Municipal Engineering

Design, Construction, Operation and Maintenance of All Public Works

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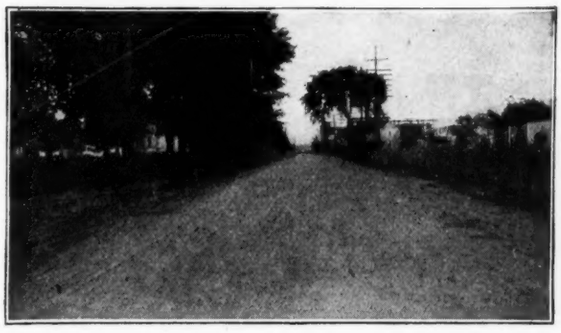

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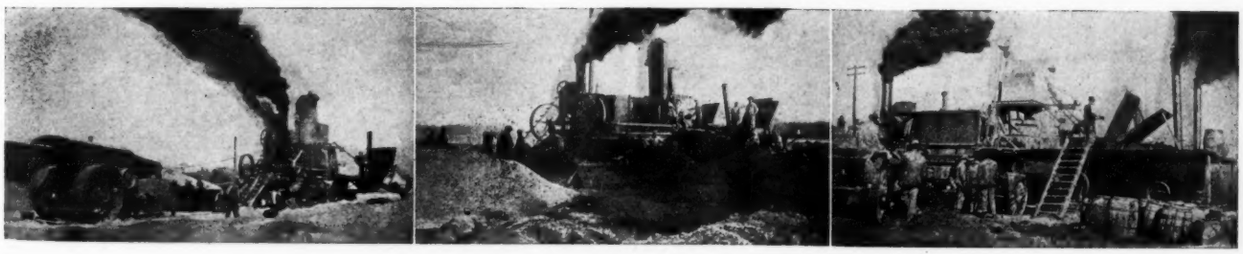

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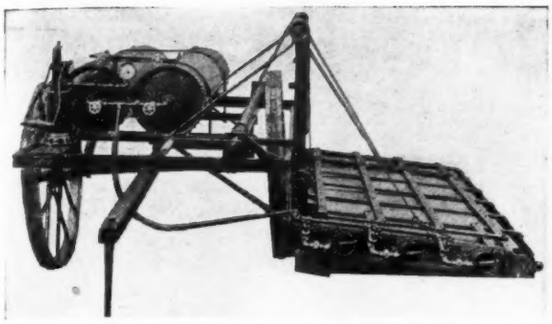

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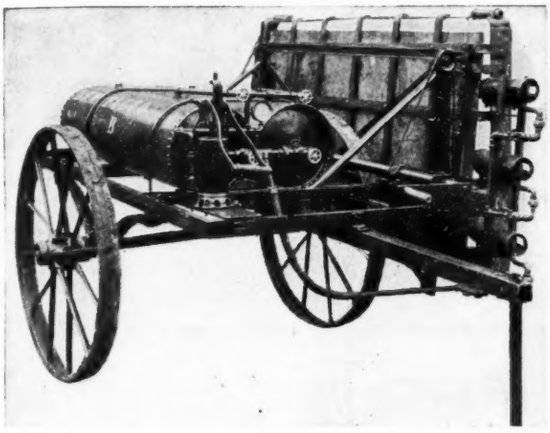

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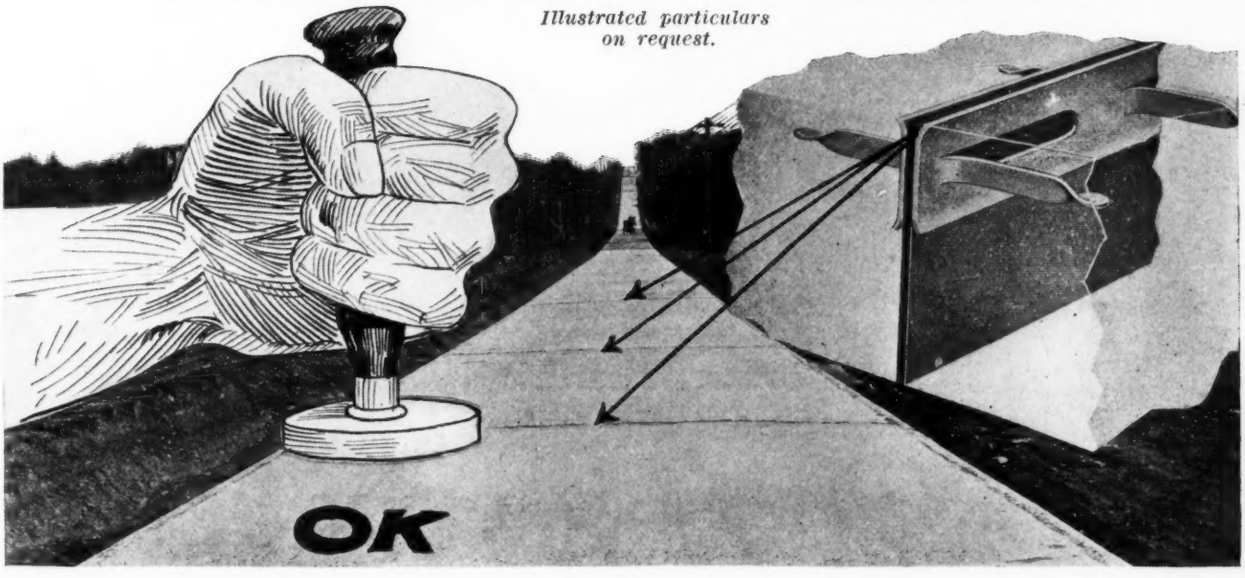

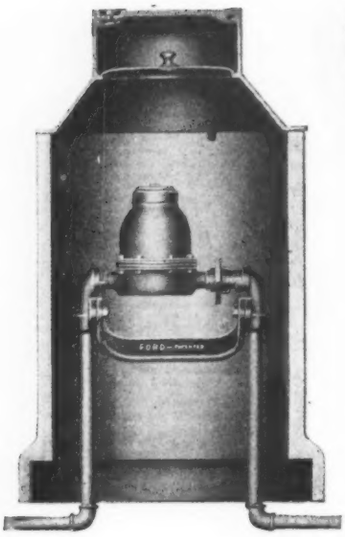

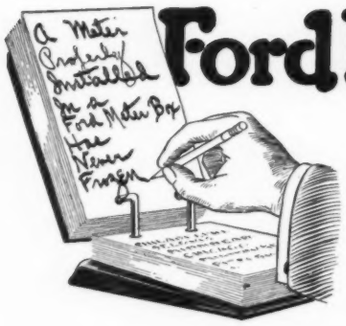

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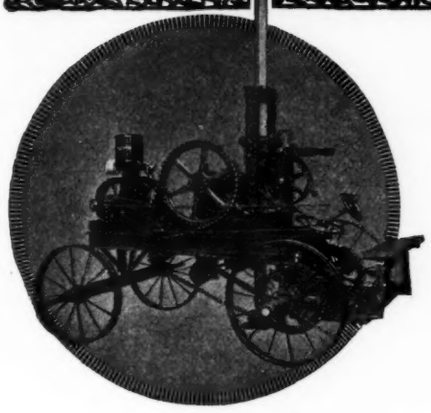

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Pawling & Harnischfeger Co.
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Made in 8, 10, 12, 14 and 16-foot sections, 8 inches wide.

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ELLWOOD CITY, PA.

Gen. Goethals on Highway Improvements.

"I am heartily in accord with a policy which will permit highway commissioners of the various States so to plan their work that they will be able to undertake the construction of new highways and of maintaining the existing ones so as to relieve railroad congestion."

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The concrete road is permanent and requires practically no maintenance. **Kahn Highway Products** insure the best construction for concrete roads, for reinforcing, for permanent joints and for protecting concrete curbs.

Write today for Highway Pamphlet and estimates.

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Large, flat sheets, easily handled—no unrolling of coils nor cutting to length. The most efficient reinforcement for concrete roads and pavements.

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Perfectly protect expansion joints. The split end prongs assure positive anchorage in the concrete, and plates are correctly placed by our Improved Installing Device.

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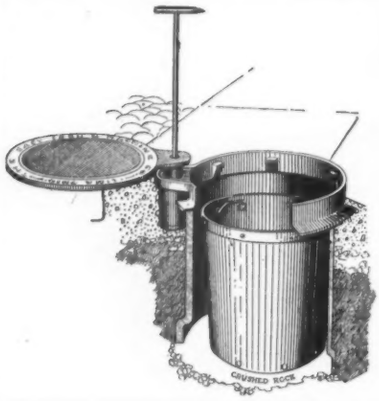

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Makers of Merriman Steam Melting Asphalt Plants.

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2. Ship all goods to be delivered within the above zones over the road by motor trucks.

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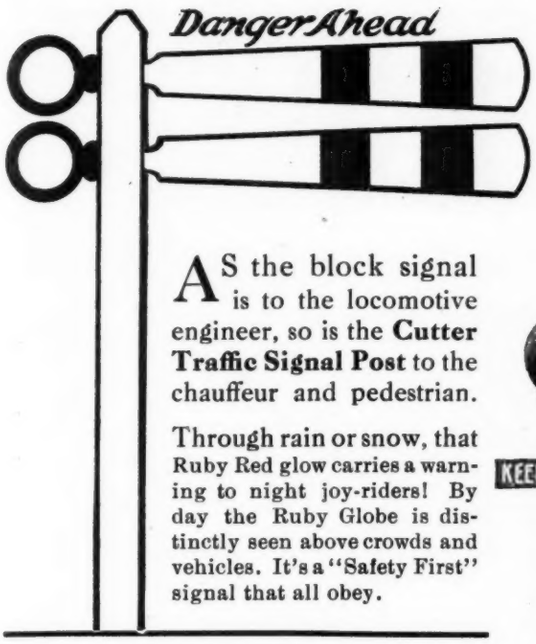
6. Put some trucks in the overland haul work on definite leaving schedules so that goods can be delivered to the receiving platforms or warehouses in time to make up full loads to any given points.

7. Bring all pressure to bear upon city officials, governors and highway commissioners to keep all the main highways open.

8. Bring all pressure to bear on the proper authorities toward the resumption of the construction of main line highways at the earliest possible moment and for a proper maintenance of the roads all year around.



AS the block signal is to the locomotive engineer, so is the **Cutter Traffic Signal Post** to the chauffeur and pedestrian.

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Means and methods of accomplishing these very desirable savings are described in the booklet illustrated above, which will be sent to any one without obligating him in the least.

This booklet is published *for distribution.* If you are interested directly or indirectly in culverts or culvert construction, it will be well worth your while to read this illustrated treatise on the subject, and we will be pleased to send it to you on request.

Storms Manufacturing Co.

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Manufacturers of the HALL Truck
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Their advertisements have *originality* and plenty of life, which *distinguishes* their advertising from many other publications; also, their magazine contains *valuable* information and items of much interest to Manufacturers and Users of Road Building Equipment and Motor Trucks.

Yours very truly,

Lewis-Hall Iron Works,

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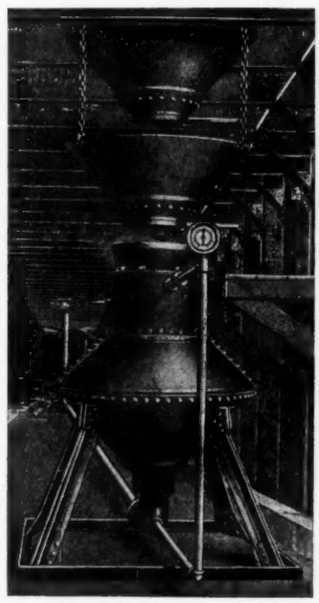
Pneumatic Process

Perfect Concrete
Any Pressure — Any Velocity



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Patent Release Valves reduce wear on elbows.

No skilled operators required.

Get in touch with us at once.

Pneumatic Concrete Machinery Co.

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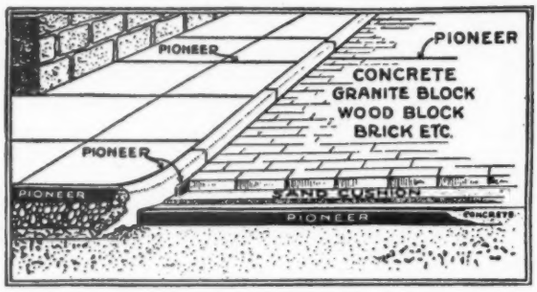
NEW YORK CITY.



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PURE ASPHALT EXPANSION JOINTS

Will stand extreme expansion of the pavement without bulging

"Pioneer" expansion joints represent the highest development of pure asphalt joint and is recommended universally for use in all kinds of paving construction.

It is tough and pliable, will not deteriorate from elements of weather, and forms a perfect bond with the sections of the pavement, completely filling the interstices when the pavement contracts.

"Pioneer asphalt expansion joints are made from the highest quality of pure asphalt filler. It has been used on a very large percentage of pavement for the past four years."

Send for a list of Pioneer Products.

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BECAUSE:

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It has character
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"If you want your **Cannon** booming at the front you must keep your **Business** booming at home."

The Highway Economist

VOL. III. MAY, 1918. No. 12.

DISCOVERY OF A CAUSE OF LONGITUDINAL CRACKS IN A BRICK PAVEMENT

By means of prompt measures taken to investigate the cause of longitudinal cracks in a semi-monolithic brick pavement in Conneaut, O., facts were ascertained which disposed of vague surmises and theoretical assumptions regarding structural defects in the pavement itself. As similar surmises and guesses are met with under similar conditions elsewhere, a statement of the facts disclosed may be of general interest.

The pavement was laid during the summer and fall of 1917. The design called for 4 in. concrete foundation (1:3:6), 1 in. cement-sand (1:4), with grouted 4 in. wire-cut lug brick for surfacing, with a 4 in. tile drain under each curb. The natural soil was yellow clay. A sewer ran under the center of the pavement, but it was placed several months prior to paving.

The pavement was laid 24 ft. wide on 16th street, Conneaut, a residential street running east and west. In February, 1918, the pavement bulged along the general median line and longitudinal cracks appeared about 4 ft. from the center of the pavement.

The longest cracks appeared in the north side of the street, but shorter cracks occurred at two or three places on the south half of the street. All the cracks were about equidistant from the center line of the street. The cracks were generally straight, not following the grouted joints but going through the brick.

City Engineer W. C. Dickey immediately cut into the pavement from the curb to the center of the pavement a width of about 20 ins., in order to ascertain the cause of the cracking.

The brick surfacing, the cement-sand bed and the concrete foundation showed no separation. The cracks extended down through brick, cement-sand bed and concrete foundation. Nor had the foundation lifted away from the sub-grade, but the sub-grade or soil was frozen hard to a depth of 38.2 ins. in the center of the street and the entire sub-grade at that point had bulged up, exerting tremendous upheaving force, until the stress of the uplifting pressure had fractured the 9 in. beam of the pavement.

Along the curbs the soil was frozen less solidly and the frost line was only 19.2 ins. below the surface. There was no heaving along the curb. The heaving was confined to the center of the street and it covered an area approximately one-third the width of the pavement or about 8 ft.

The longtitudinal cracking was not due to any defect in the pavement nor to any fault in construction, it was wholly due to the upheaval of the entire underlying clay bed.

The severe winter, with continuous cold weather for many weeks, the temperature frequently dropping below zero and several times going as low as 15 degrees to 18 degrees below zero, caused the deep freezing of the sub-grade especially under the center of the pavement where the concentrated traffic kept the snow packed hard.

It may be assumed, theoretically, that the shallower frost line near the north curb was due in part to the reduction of the moisture content of the clay in the area directly affected by the tile drain, and in part by the fact that the north side of the street received the direct rays of the sun several hours a day during the winter. The blanket of soft snow along the curbs may have been a contributory cause.

Clay drains very slowly, and under cover it seldom drains quite dry. It is not likely that the tile drains under the curbs on a 24-ft. street would drain the entire sub-grade of clay; hence the greater volume of moisture under the center of the pavement and the greater depth to which the frost penetrated there. The lifting power of the sub-grade was exerted at the crown of the pavement, and the fracture in the pavement occurred at a line approximating the line of demarkation between the stationary sub-grade in the area of comparatively shallow frost and the area of greatest frost depth and consequent greatest upheaving movement of the soil.

The practical question appears to be whether multiplication of tile drains under pavements laid on clay soil or a course of compacted gravel placed over the clay soil before the concrete foundation is laid is the best method of averting troubles such as arose on 16th street, Conneaut.

In the same city during the winter of 1917-18 an asphalt pavement bulged 3 ins. at certain places, but brick pavements laid directly on gravel soil with no artificial foundation neither bulged nor cracked.

Basing judgment on all these facts, it seems to be a theoretically sound conclusion that in the northern states on clay soils exceptionally thorough drainage is required in order to avert longitudinal cracks in brick pavements, but that on sandy or gravelly soil there is little danger of longitudinal cracks if ordinary care is exercised in providing drainage. Neither sand nor gravel holds water as does clay, and neither sand nor gravel expands in volume or heaves with the force characteristic of clay.

Some idea of the force exerted upward by frozen clay may be formed by considering that in order to bulge a square yard of brick pavement, even if the square yard of pavement be not held in place by curbs and by the strength of the entire slab, to which it is bonded, a weight of 400 lbs. of brick, with the bonding grout, the square yard of 1 in. cement-sand cushion and the square yard of 4 in. concrete base added, must be lifted.

The total dead weight of a segregated square yard of brick pavement of this type is about 900 lbs. In order to heave an unbound area paved with 1,000 standard brick, a lifting force sufficient to raise a slab having a dead weight of 11¼ tons or 22,500 lbs., must be exerted.

These calculations are based upon dead weights, not taking into account the wedging of the slabs by adjoining portions of the pavement. In order to lift and break the wedged-in area, a much greater force than is required to lift dead weight is exerted.

In this connection, the factor of expansion of brick under thermal influences is eliminated, as brick do not expand during cold weather. The cause of the longitudinal cracks in the case in hand was due, therefore, entirely to extraneous forces applied to the pavement mechanically from below.

Several questions involving preventive measures will occur to the engineer:

(1) Would the omission of the under-curb drains cause the natural soil under the pavement to freeze at an equal depth under the whole pavement area? And would the resultant heaving of soil be uniform, raising the entire pavement but not causing longitudinal cracks?

(2) If the drains under the curb drain moisture from a limited area in a parabolic curve from the top of the sub-grade to the drain, but at all points above the horizontal plane from curb drain to curb drain, would a drain placed under the center of the pavement at a point just below the frost line and relatively lower than the curb drains, take care of the water not drawn off by the curb drains?

(3) If the curb drains fail to take care of the water in the clay under the center of the pavement above the frost line, would a multiplication of tile drains, placed equal distances apart on a plane with the curb drains solve the drainage problem?

(4) Would a bed of gravel placed on top of the clay reduce the hazards of sub-grade heaving? If this would be the case, how deep should the gravel be spread?

(5) What functions would the gravel perform? Would the voids take up from the clay enough water to relieve the clay of any portion of the expansive effects of frost?

(6) Would the gravel, which drains naturally and does not readily absorb water, have a tendency to distribute the upward thrust of the frozen clay soil, and serve as a buffer cushion?

(7) It has been alleged that the heaving of the frozen soil does not extend to the lower frost line, nor does it occur as a result of the first freezing, but is confined to a limited depth from the top of the soil in consequence of alternate thawing and freezing of this upper stratum in late winter or early spring. The theory of this is that when the thawed top soil becomes saturated with water gathered either by seepage or capillary action, and again freezes hard, the frozen soil below prevents expansion downward, so that the whole force of the thrust is upward, and rupture of the pavement occurs at the weakest part. If this be true, would not a layer of gravel over the clay avert this heaving action or at least so reduce its force as to bring the thrust within the resisting power of the pavement?

The problem seems to be one involving the best means of handling clay soils under pavements, without running into excessive costs, and this

For Heavy Traffic Streets

"METROPOLITAN" OR "BESSEMER"

Commerce Street, Youngstown, Ohio, paved with **Bessemer** Block in 1909, sustains the tremendous volume of traffic from nearby warehouses and freight terminals in that thriving street center. **"Metropolitan"** and **"Bessemer"** shale paving Brick have a National Reputation for Uniformity and Satisfaction in use under the ***most exacting*** conditions—they "Stand Up" under the *heaviest* traffic.

Repressed and Wire-Cut Lug

THE METROPOLITAN PAVING BRICK CO.

"The World's Largest"

CANTON, OHIO

question is of sufficient importance to engage the professional attention of engineers and lead to practical experimentation.

Paving Brick Used for Station Platforms

Railroads at the present day build for durability. Dependable service means efficiency and economy. This applies to small as well as large construction work, such as station platforms, freight house platforms, floors, driveways, etc.

The importance of durable work is recognized, as well as the fact that durable work cannot be done without the use of durable materials.

Paving brick are being used very extensively by railroads and industrial plants for the purposes above indicated.

Vitrified brick is the most durable wearing material known. Laid monolithically, it stands the shock of impact of heavy bodies; it does not chip or wear away under heavy trucking on large or small wheels; it is not affected by the action of water, acids or oils. A monolithic brick pavement is smooth and clean. It neither gives off fine particles of dust, nor ruts, nor pits, nor ravels, nor disintegrates.

The wearing surface never wears out if the brick are kept on an even, stable base and are well bonded.

Monolithic brick pavements for platforms and floors require very little foundation—none at all except 1 in. of cement-sand mortar bed, if the natural foundation be properly prepared.

In cleanliness, smoothness, durability, vitrified brick flooring for factories, plants, machine shops, station platforms and freight house floorings and platforms is coming into more general use every year, as the merits of brick become more widely known.

The new freight station of the Pennsylvania railroad, at Buffalo, N. Y., is so paved. The great municipal docks and piers at Jacksonville, Fla., are paved with brick. Among other big concerns using vitrified brick for paving either floors, approaches, driveways, platforms or areas are some of the largest in the United States and Canada, including steel plants, electrical plants, various manufacturing companies, and railroads.

A competent foreman can lay vitrified brick floors and platforms with unskilled labor. The cement-sand mortar bed is mixed 1 part cement and 4 parts sand, and the cement-grout for filler bond between the brick is mixed 1 part cement and 1½ parts sand.

Either a standard 4 in., or a 3 in. smooth surface brick can be used. The latter make a pavement amply strong to withstand any traffic likely to pass over platforms or floors or approaches.

The superficial area of standard paving brick is 3½ ins. wide, exclusive of the lugs, and 8½ ins. long. These dimensions are common to paving brick either 4 ins. or 3 ins. deep. The brick lay 40 to the square yard, so that it is easy to estimate the number of brick required for paving a given area.

When Mr. Charles F. Mayer was a high official of the Baltimore & Ohio railroad, he said:

"I have been giving a good deal of attention for some time past to the vitrified brick pavements now being used extensively * * * and our use of them around our freight and passenger stations. The result of these observations prompts me to call attention to the pavement of the future. The above is not simply the result of my observation, but of the close and careful observation of some of our most trusted officials."

Springfield Wire-Cut Lug

IS WIDELY USED

The square edges *stay* square, due to the spacing lugs and beveled ends. Both Dunn Wire-Cut Lug and Frost Process. Sewer and Building Brick—also very artistic Rug Face Brick.

Springfield Paving Brick Co.

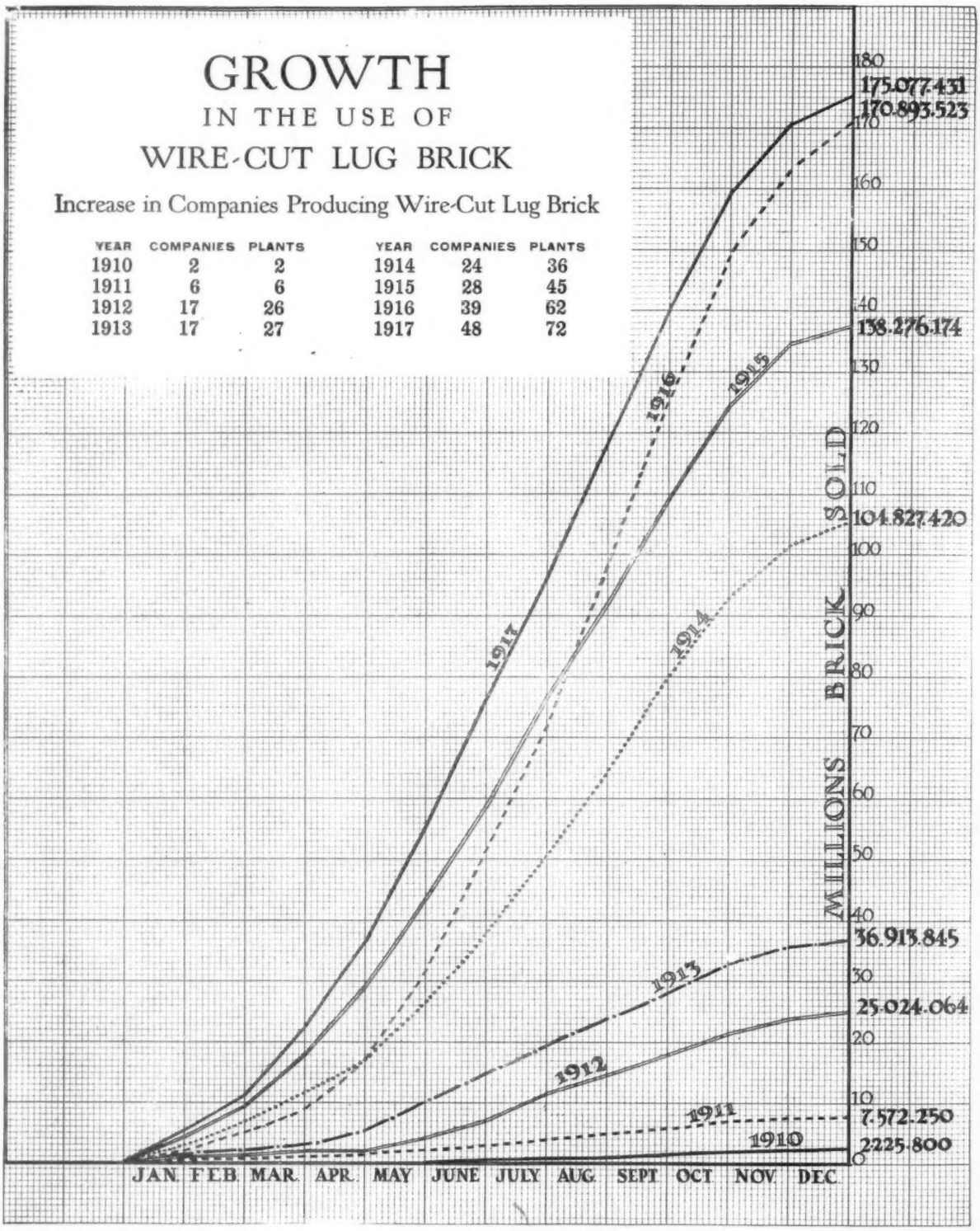
SPRINGFIELD, ILLINOIS

MEDAL BLOCK
"The Block with Experience behind it"
BUYING cheap goods to save money, is like stopping the clock to save time; and this applies to many types of road surfacing material. If you want the only sure, durable and reliable road surface, buy
MEDAL BLOCK
"The Block with experience behind it"
Manufacturers of Medal Block for 23 years.
Manufacturers of Paving Brick for 29 years.
Oldest in service unexcelled in quality.
Medal Repressed, Wire-Cut-Lug and Hillside Block.
23 YEARS SERVICE
Capacity 35,000,000 annually.
THE MEDAL PAVING BRICK COMPANY
FORMERLY THE DECKMAN-DUTY BRICK CO.
1305-1308 Swetland Building
Cleveland, Ohio

GROWTH
IN THE USE OF
WIRE-CUT LUG BRICK

Increase in Companies Producing Wire-Cut Lug Brick

YEAR	COMPANIES	PLANTS	YEAR	COMPANIES	PLANTS
1910	2	2	1914	24	36
1911	6	6	1915	28	45
1912	17	26	1916	39	62
1913	17	27	1917	48	72



THE DUNN WIRE-CUT LUG BRICK CO.

(LICENSORS) CONNEAUT, OHIO

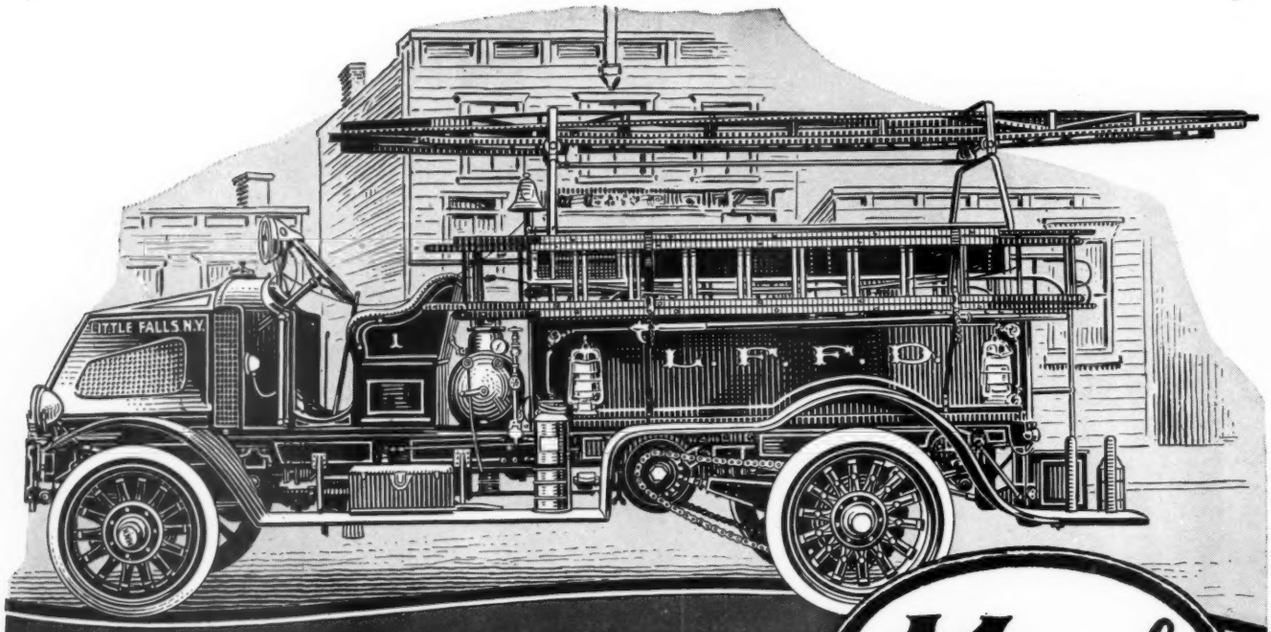
MOTOR TRUCKS

Motor Trucks as Operated in the Intercity and Interstate Haulage of Freight on the Highways.

(FOURTH INSTALLMENT)

SERVICE 5-TON MOTOR TRUCK AS OPERATED BY THE GLOBE EXPRESS LINE IN LONG DISTANCE MOVING AND IN GENERAL INTER-CITY AND INTERSTATE HAULAGE OF FREIGHT.

Printed as insert to Municipal Engineering, May, 1918.



Mack
TRUCKS

Serves Threefold Purpose

Communities facing the necessity of modernizing or increasing their fire-fighting facilities and having but limited funds for the purpose will do well to investigate this MACK triple combination specially equipped for any emergency.

The responsibility that centers on the fire-fighting equipments of a city was fully appreciated when Little Falls selected this MACK 40 H. P. Triple Combination Chemical, Hose and Ladder Truck capable of a speed of 35 miles per hour. Equipment consists of:

> One 35 ft. trussed extension ladder; one 24 ft. trussed extension ladder; one 14 ft. roof ladder; one 40 gallon chemical tank with 200 feet chemical hose; and body capacity of 1500 feet of fire hose.

Dependability at all times was a major consideration. The records of MACK fire-fighting apparatus in other municipalities proved that MACK trucks are always ready in any emergency.

Little Falls is hilly, but the MACK truck's well known ability to "iron out" steep grades disposed of the hill-climbing problem.

Correspondence is invited on motor equipment of every description.

INTERNATIONAL MOTOR COMPANY
NEW YORK

Performance Counts

HIGHWAYS

The Only Sure Relief from the Transportation Menace

Highways mean motor trucks.

Look the facts squarely in the face.

The war is 85 per cent industrial and 15 per cent military.

And our industrial strength is greatly handicapped—put out of the running through the lack of adequate transportation facilities.

You can't blame the railroads. They have all and more than they can do to handle the tremendous volume of freight now on their tracks. Their rolling stock is tied up—their terminals congested.

Garford Motor Trucks

The highway offers the only sure relief from the transportation menace that is threatening the very life of American industry—*the highway and motor trucks.*

You can do your Country a service and help your own business by utilizing motor trucks consistently for all short haul and inter-city deliveries.

Garford Motor Trucks are furnishing such service to hundreds of business men who pride themselves on being practical.

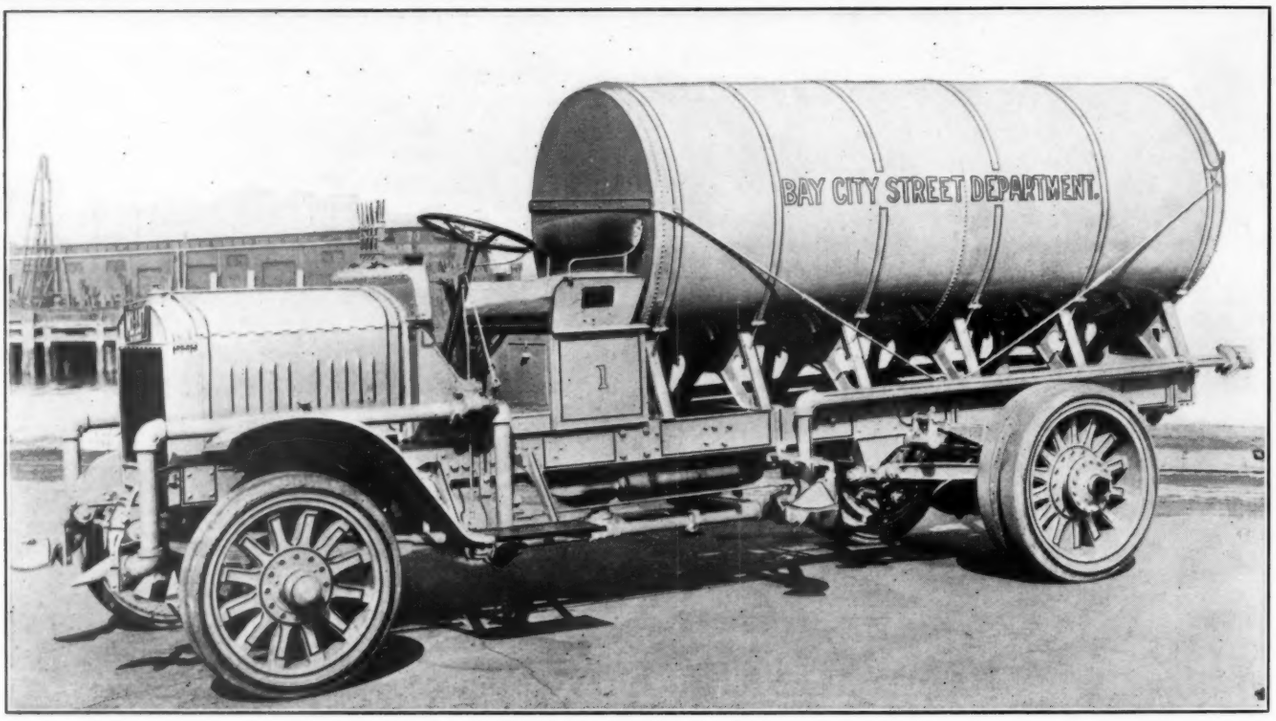
Why not you?

Catalogue on request—address Dept. 107.

The Garford Motor Truck Company, Lima, Ohio

Manufacturers of Motor Trucks of 1, 1½, 2, 3½, 5 and 6 ton capacity
4½, 7 and 10 ton Tractors

The Garford Road Builder



GMC Municipal Service

The varied but exacting demands of motor truck efficiency in the widely differing phases of municipal operations are all completely met in the GMC.

Great power and strength, durability, safety and speed are among the features that are called for in the various departments of municipal work.

Whether for ambulance duty, police patrol or the fire department which demand speed and safety, or the heavier work of road building, street sprinkling, garbage hauling and other uses calling for greater strength, GMC trucks can always be depended upon absolutely.

The GMC especially typifies three of the most desirable features in truck building—strength, simplicity, and economy of upkeep. Every unit in its construction is made stronger than is demanded by normal conditions of wear so that any emergencies calling for extra strength or power are fully met. This prevents undue strain, prolongs length of service and reduces the running expenses to the lowest legitimate minimum.

Victor F. Lawson, publisher of the Chicago Daily News, wrote us recently that a GMC truck he has on road work carried 23,000 tons of crushed stone in eight months without a cent of expense except operation.

The repeated purchases of GMC trucks by the City of Chicago based on tests on 16 competitive points is also a practical endorsement of their merit.

In one of its various sizes from ¾ ton to 5 tons there is a GMC truck completely adapted for any branch of municipal service.

GENERAL MOTORS TRUCK COMPANY

One of the Units of the General Motors Corporation

New York Philadelphia Boston **PONTIAC, MICH.** Chicago St. Louis San Francisco

Distributors most Everywhere

(339)

MOTOR TRUCK OPERATION AND ACCOUNTING XXXIII

By Charles A. Dickens

(Concluded from April Issue)

Motor Truck Hauls Unusual Loads 10 to 300 Miles Over Country Roads

Railroad congestion and freight delay have caused thousands of manufacturers and shippers to turn to motor trucks. Business men now realize that the man with a fleet of motor trucks is virtually the owner of a railroad without embargoes, terminal congestion or car shortage.

Holroyd Brothers, 621 Brooklyn street, Philadelphia, are one of the many thousands of firms who have thrown the motor truck into the breech created by railroad embargoes and tie-ups.

They operate a 3½-ton U. S. truck hauling machinery, forgings and riggers' and builders' supplies. The nature of the materials of which the loads are made up causes them to be of unusual shape and extremely cumbersome. At times a two-wheeled trailer is used and the loads carried are as heavy as 10 tons. Trips range from 10 to 300 miles.

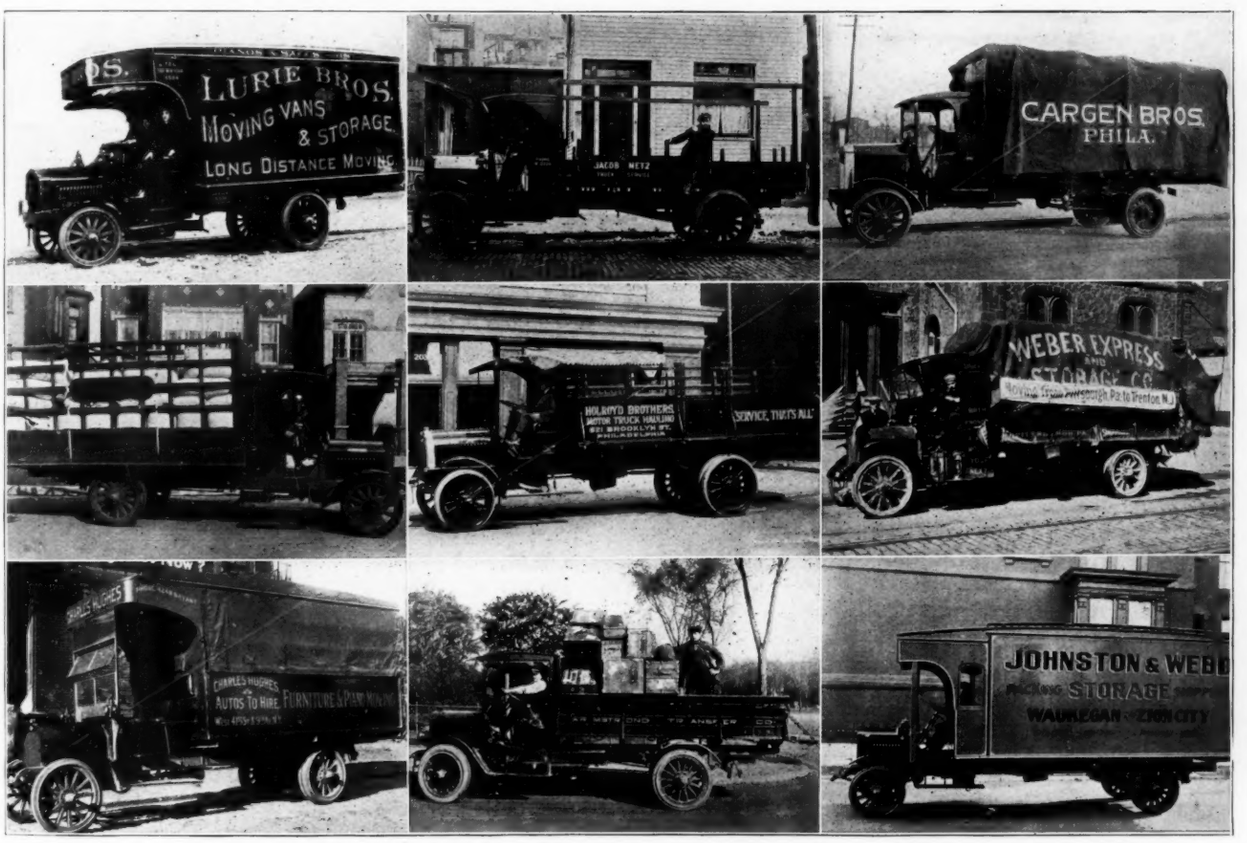
Recently this truck hauled 4 tons of riggers' supplies and pulled 5 tons of timber on the two-wheeled trailer through the congested traffic of Philadelphia and over 30 miles of rough country roads.

The cost of operation in connection with this U. S. truck has been found to be exceptionally low, even though the service in which it is operated is one to test a motor truck to the utmost.

Such successes as this bring into clearer view the increasing importance of the motor truck as a means of transportation.

Federal Trucks in Intercity Haulage

Transportation congestion has certainly presented a proposition in which motor trucks take no little part. Roads are being put into shape to carry on intercity haulage, and many



VIEWS OF MOTOR TRUCKS AS OPERATED IN THE INTERCITY AND INTERSTATE HAULAGE OF FREIGHT ON THE HIGHWAYS.

LEWIS-HALL TRUCK AS OPERATED BY LURIE BROS., NEW YORK CITY, IN LONG DISTANCE MOVING.

MASTER TRUCK AS OPERATED BY RADLEIN'S MOTOR EXPRESS CO., CHICAGO, IN GENERAL FREIGHT HAULAGE.

DIAMOND T TRUCK AS OPERATED BY CHARLES HUGHES, OF NEW YORK CITY, IN INTERBOROUGH HAULING.

SCHACHT TRUCK AS OPERATED BY JACOB METZ TRUCK SERVICE, CINCINNATI, IN INTERCITY FREIGHT HAULAGE.

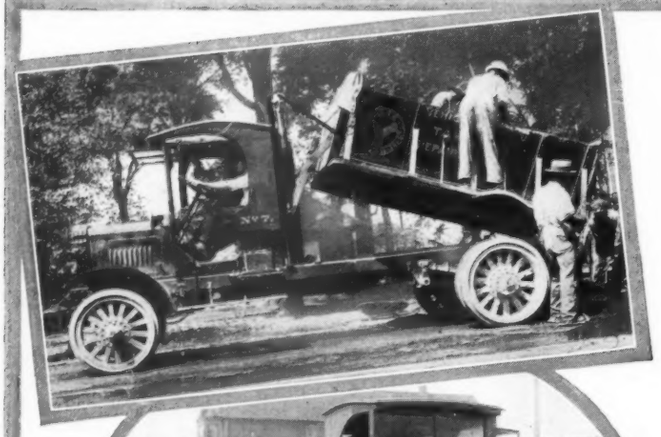
U. S. TRUCK AS OPERATED BY HOLROYD BROTHERS, MOTOR TRUCK HAULING SPECIALISTS, PHILADELPHIA, PA.

WILSON TRUCK AS OPERATED BY ARMSTRONG TRANSFER CO., BOSTON, IN MAKING SUBURBAN DELIVERIES.

ARMLEDER TRUCK AS OPERATED BY CARGEN BROS., PHILADELPHIA, PA., IN HAULING FREIGHT BETWEEN CITIES.

FEDERAL TRUCK AS OPERATED BY WEBER EXPRESS AND STORAGE CO., PITTSBURGH, IN MOVING TO TRENTON, N. J.

SERVICE TRUCK AS OPERATED BY JOHNSTON & WEBB, OF WAUKEGAN, ILL., IN HAULING BETWEEN ILLINOIS TOWNS.



For Municipal Work

Service
MOTOR TRUCKS

Do as Chicago city officials did—select trucks on a strictly efficiency basis. Put Service Trucks side by side with any other make—let the evidence convince you. You can't afford to make such an important purchase as a truck on mere hearsay or sentiment. Get at the facts.

City of Chicago Bought Seven 5-ton Service Trucks

as the result of a rigid and impartial efficiency test. Service won out over 12 other leading makes including all of the "Dominant Seven." Service motor trucks not only offer **extra big value** to the purchaser, but they have many marked advantages.

Only ***one other*** of the "Dominant Seven" is built to operate with perfect safety at the speed of Service Trucks.

Only ***one other*** of the seven furnishes tires on all the models that equal Service in size.

Only ***three others*** use motors equal in power to Service. And for **equal capacities** Service shows 11% higher rating than the **other three.**

All use pressed steel frames. But the Service pressed steel frame has **wider** flanges, **greater** depth and **more uniform distribution of the load.** It assures maximum resistance to driving stress and strain.

In chassis size Service gives greater loading length than any of the other seven. This means greater carrying capacity—a more even distribution of the load.

Yet, with all these features of superiority—strength—power—speed—capacity—economy—Service Motor Trucks **are extremely low in initial cost.**

Write for Special Bulletin

showing Service Trucks in six models and five sizes—1 to 5 tons—with bodies for every requirement.

Service Motor Truck Company

Dept. M-3 Main Office and Factory, WABASH, IND.

Chicago, Ill.	Milwaukee, Wis.	Hoboken, N. J.
New York, N. Y.	Bridgeport, Conn.	Philadelphia, Pa.
Norfolk, Va.	Des Moines, Iowa	Rochester, N. Y.
St. Louis, Mo.	Baltimore, Md.	Tulsa, Okla.
Louisville, Ky.	Columbus, Ohio	Detroit, Mich.
Omaha, Neb.	Cincinnati, Ohio	Denver, Colo.
Boston, Mass.	Youngstown, Ohio	Knoxville, Tenn.
Brooklyn, N. Y.	Canton, Ohio	Memphis, Tenn.
Newark, N. J.	Pittsburgh, Pa.	Birmingham, Ala.
Indianapolis, Ind.	Washington, D. C.	Dayton, Ohio
Buffalo, N. Y.	Savannah, Ga.	Nashville, Tenn.
Salt Lake City, Utah	New Orleans, La.	Toledo, Ohio

SERVICE TRUCKS, FROM 2 TO 5 TONS CAPACITY, READY TO START FROM WABASH, IND., TO NEW YORK CITY, CARRYING CRATED PASSENGER CARS.

manufacturing concerns and express companies have established regular overland routes to facilitate transportation by motor truck, thereby releasing the most important aid to freight congestion.

In Kalispel, Mont., Mr. George Morris operates a Federal freight service, traveling over a route between Kalispel and Somers, Mont. Mr. Morris has found that he can compete with the express companies in a haul of this distance, and carries all kinds of freight. Mr. Morris is not the only one who has resorted to this means of aiding manufacturers in distributing their products. The American Transfer Company, of Los Angeles, Cal., is making daily trips between Long Beach and Los Angeles, and hundreds of others have already realized the possibilities of permanent routes being established throughout the country.

It is almost an impossibility to obtain freight cars for shipping Federal trucks, but that nevertheless does not prevent Federal dealers from getting them. Recently one of the dealers came to the factory to get some trucks, and drove seven with him back to Baltimore, Md.

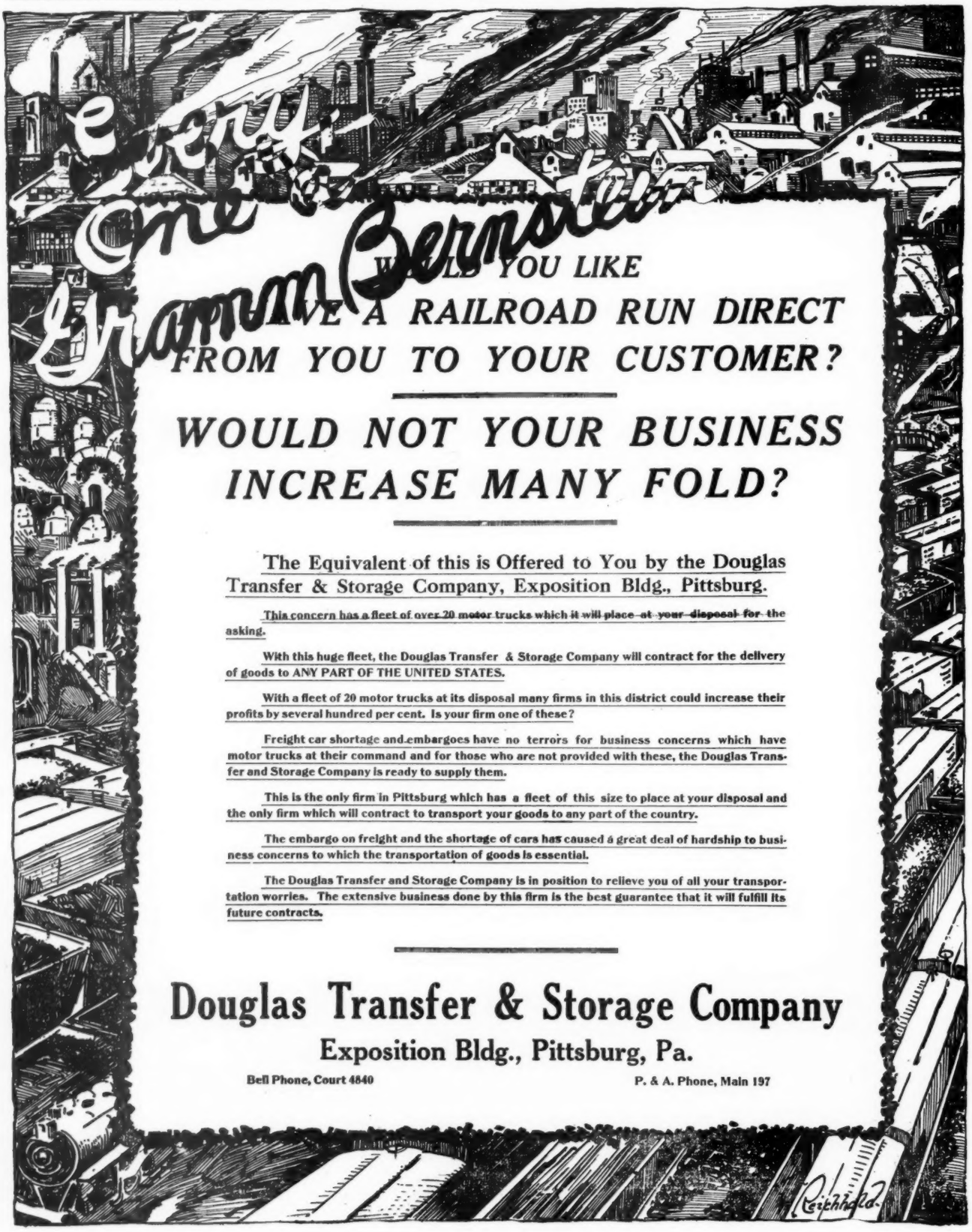
Recently the Washington dealer was in need of some Federal parts and decided to drive them through. Although the roads were covered with deep snow and transportation seemed almost impossible for such a distance at the time, he decided to attempt the trip. When the trucks got to Akron, Ohio, there were awaiting him several loads of tires which were to be carried to Baltimore, and the Washington dealer did not hesitate for a minute to load them and take them along. The trip was made in good time, and in spite of the bad roads the trip was accomplished in a satisfactory manner.

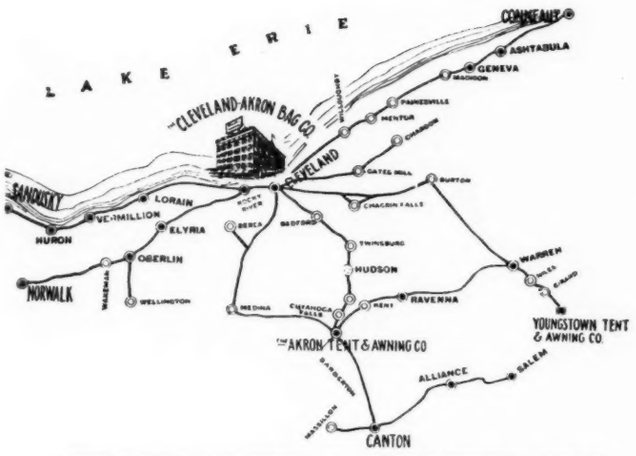
Mr. Hamilton J. Brannagan, of Philadelphia, Pa., has greatly increased his service to the business men of that city by the use of Federal trucks. Mr. Brannagan has two 3½-ton Federals equipped with stake bodies and a third of the same capacity with a steel dump body. Mr. Brannagan will haul anything and everything anywhere.

It is almost an impossibility to get cars to move furniture from one city to another, but Bush's Express of Caldwell, N. J., very satisfactorily substitutes the railroad freight transportation. When Bush moves goods from Caldwell, N. J., to another city, waiting for freight cars is unnecessary. Paying demurrage on the cars after they arrive at their destination is absolutely uncalled for, and the delay, inconvenience and annoyance of waiting for the goods to arrive is entirely eliminated. Bush will move one of his large vans in front of the house, load the goods and unload it in the city in which the customer intends to move right in front of the door. There is no waiting, broken furniture or anything of that sort.

So great were the odds against the 2-ton Federal owned by F. E. Lewis of Ridgefield, Conn., that Superintendent Ballantine never expected it to get through to New York City with a load of wood and coal. The people of New York were certainly at their wits' end to get fuel during the recent coal famine. The fuel was so badly needed in New York that Mr. Ballantine determined to get it, even though 60 miles of impassable roads intervened.

G. M. C. TRUCK AS OPERATED BY O. D. H. HAMLIN, OF COTTONWOOD, IDAHO, IN INTERCITY HAULING IN ALL PARTS OF IDAHO, OVER ALL KINDS OF ROADS.


Every One
Wants
Telegram Service
WOULD YOU LIKE
HAVE A RAILROAD RUN DIRECT
FROM YOU TO YOUR CUSTOMER?
WOULD NOT YOUR BUSINESS
INCREASE MANY FOLD?
The Equivalent of this is Offered to You by the Douglas Transfer & Storage Company, Exposition Bldg., Pittsburg.
This concern has a fleet of over 20 motor trucks which it will place at your disposal for the asking.
With this huge fleet, the Douglas Transfer & Storage Company will contract for the delivery of goods to ANY PART OF THE UNITED STATES.
With a fleet of 20 motor trucks at its disposal many firms in this district could increase their profits by several hundred per cent. Is your firm one of these?
Freight car shortage and embargoes have no terrors for business concerns which have motor trucks at their command and for those who are not provided with these, the Douglas Transfer and Storage Company is ready to supply them.
This is the only firm in Pittsburg which has a fleet of this size to place at your disposal and the only firm which will contract to transport your goods to any part of the country.
The embargo on freight and the shortage of cars has caused a great deal of hardship to business concerns to which the transportation of goods is essential.
The Douglas Transfer and Storage Company is in position to relieve you of all your transportation worries. The extensive business done by this firm is the best guarantee that it will fulfill its future contracts.
Douglas Transfer & Storage Company
Exposition Bldg., Pittsburg, Pa.
Bell Phone, Court 4840
P. & A. Phone, Main 197



TERRITORY COVERED IN MOTOR TRUCK DELIVERIES BY THE CLEVELAND-AKRON BAG CO., OF CLEVELAND, OHIO.

The truck left Ridgefield at 11 a. m. one day just after a severe snow storm. "The thermometer was 5 below zero and a strong wind was blowing. The roads were covered with ice and snow," says Mr. Ballantine. "Personally, I never thought the Federal would get there. At 7 p. m., eight hours later, I got word from the driver that he arrived O. K. and never had a bit of trouble all the way down, which speaks volumes for the staying quality of the truck."

Many companies operating trucks in intercity haulage found this quality of particular advantage, and never once during all of the snow storms or blizzards were Federal owners compelled to lay up their trucks and postpone their schedule until the weather cleared. They were always on the job.

Within a radius of some 50 miles from Richmond Hill, N. Y., the Dillman Bakery, Inc., have almost a monopoly on the "home-made bread" consumed. They are operating a fleet of twelve Federal trucks, which thoroughly cover Richmond Hill and the vicinity.

Motor Truck Beats Fastest Freight by 48 Hours on 533-Mile Trip

In making the recent 533-mile trip, overland from New York to Akron, O., in 60 hours, total time, and in 49 hours actual running time, a loaded 3½-ton Mack truck beat the fastest Pennsylvania Railroad freight delivery by 48 hours.

This remarkable feat of overland truck transportation was at the instance of the Goodyear Tire and Rubber Company, which maintains a through truck service between Akron and Boston. The rubber company now has eight trucks running on regular schedule, and what is more important, these trucks have been operated through the deep snows of the recent winter.

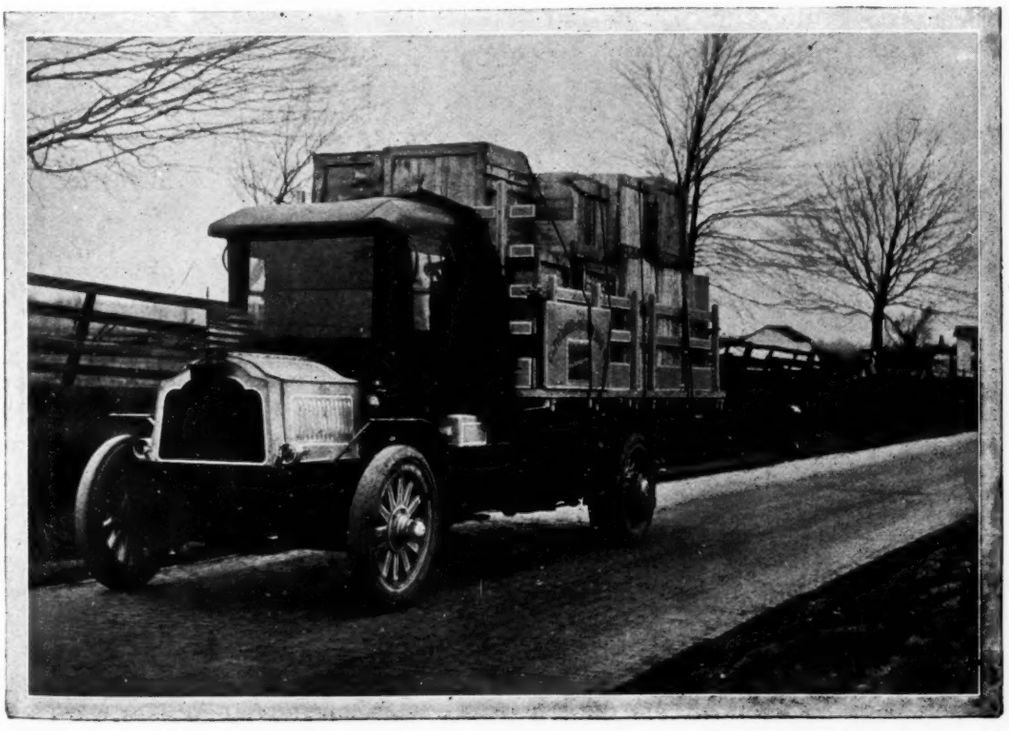
These overland trips serve a dual purpose, although the principal reason is to test out the giant pneumatic tires being produced by the Goodyear company. The carrying of freight serves the practical purpose of relieving railroad congestion and gives test to the tires and trucks under the same conditions to be met in actual service. At first the truck manufacturers were skeptical as to the possibility of the project, but the Goodyear company insisted and finally started a truck on the first leg of the journey from Akron early in April of last year. The trip took 17 days. Today the same truck and others of the fleet make the identical run in 4 days and in several instances a complete round trip of 1,480 miles has been made in 6½ days.

On the Mack record run in December, 1917, the roads were deep with snow all along the route and the thermometer registered 13 degrees below zero for a considerable portion of the run. Due to the fact that the truck was fitted with pneumatic tires all around it was able to make a speed which would have been impossible with solid tires.

U. S. Tire Co. Uses Motor Transportation, Detroit to New York

In order to help relieve railroad congestion and at the same time insure prompt deliveries of tires to their dealers, the United States Tire Company established a system of motor-truck transportation between Detroit and New York.

The first truck loaded with 4,300 pounds of tires, arrived in New York recently from the Detroit factory of the tire company after encountering the fiercest snows of the winter on the way East. The vehicle, a 2-ton Pierce-Arrow, was equipped with Nobby Cord pneumatic truck tires, and despite the strenuous work called upon to perform, neither truck nor tires showed signs of wear.



MOTOR TRUCK AS OPERATED BY THE CLEVELAND - AKRON BAG CO., CLEVELAND, OHIO, IN DELIVERING THEIR PRODUCTS TO OHIO CITIES, AT LESS COST THAN EXPRESS SHIPMENTS TO SAME POINTS.

The Seal of Dependable Performance

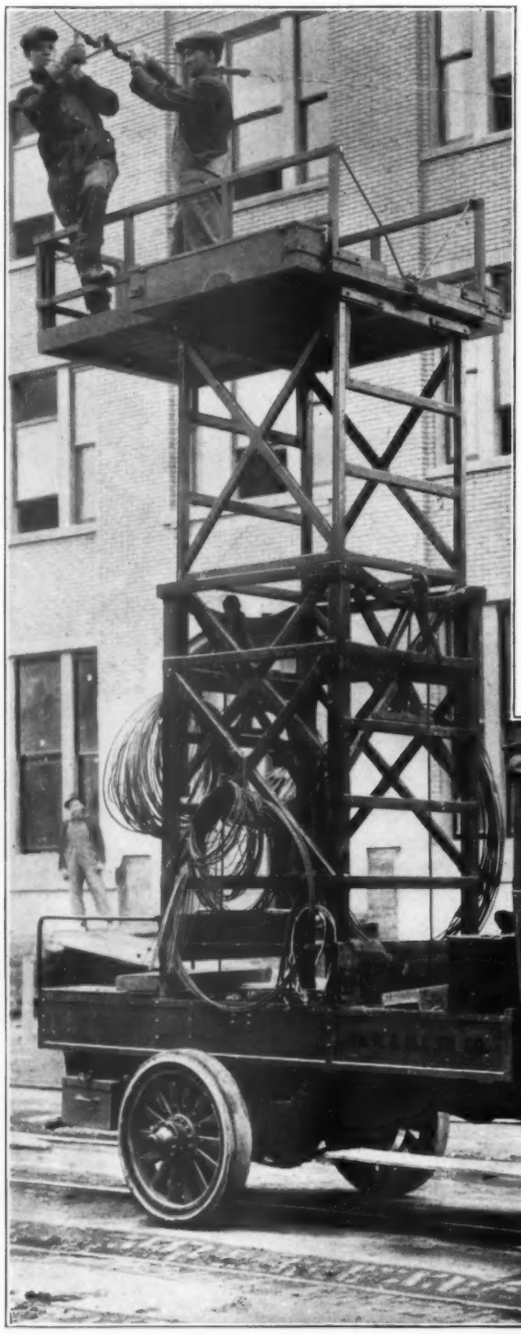
ACME THE TRUCK OF PROVED UNITS

Trade Mark Reg. U. S. Pat. Off.

The Standardized Truck

Saves You Money—Time—Man-Power

We have the facts and figures which prove that the **Acme** user in the contracting field can figure his costs under the other fellow's—and yet make the same profit. Let us show you these figures.



ACME

Proved Units are Combined Perfection

—the master products of sixteen master manufacturers. Study the names. Each stands for supremacy.

Write for New ACME Book

It's entitled ***"Pointers to Profits,"*** and it is. Write on your letterhead for a copy.

ACME MOTOR TRUCK COMPANY

158 Mitchell Street. CADILLAC, MICH.

One-ton to Four-ton Models- Each oversized in both capacity and dimensions

ACME PROVED UNITS

Continental Motor Timken Axles Timken Bearings Timken Worm-Drive Centrifugal Type Governor Stewart Vacuum Feed Rayfield Carburetor Cotta Transmission Borg and Beck Clutch Ross Steering Gear Pressed Steel Frame Hayes Artillery Type Wheels Blood Bros. Universal Joints Eisemann High Tension Magneto Tubular Truck Type Radiator Detroit Springs

HELP WIN THE WAR—*Relieve the railroads*

Reduce your delivery costs and end delays with the ACME in your service.

FEDERAL TRUCK AS OPERATED BY THE E. A. HARTFORD EXPRESS ON THE ROAD TO CONCORD, N. H., WITH A LOAD OF HOUSEHOLD GOODS.

The run from Detroit to Buffalo was made in 28½ hours, excellent time when the conditions are taken into consideration. But between Buffalo and Albany the truck experienced the worst roads and heaviest snows of the trip. Snowdrifts completely obscured the road, making it impossible for the driver to avoid the ruts. This not only slowed down the speed of the last half of the journey, but added materially to the strain on truck and tires.

Performance of Pierce-Arrow Fleet at Los Angeles

Los Angeles, as one of the greatest motor trucking centers in the United States, has witnessed many forceful demonstrations of motor truck efficiency, and there is one that lingers as a strong example of what can be expected of heavy-duty machines.

When a great number of 23½-ft. sections of 12-in. pipe had to be moved from Los Angeles into the San Fernando Valley to points far removed from railroads, the transportation problems proved perplexing until the motor truck entered the situation.

A test was made with a 5-ton Pierce-Arrow truck and a trailer of 5 tons capacity, owned by the Advance Truck Company. Fifty-six sections of the pipe, weighing a total of 12 tons, were loaded upon the Pierce-Arrow and trailer, and it fairly raced away with its cumbersome load. The time, money and labor saved by motor truck transportation in this one big project alone ran into great sums.

A striking example of the utility of the motor truck is being given every day by the Advance Truck Company's fleet. A keenly felt shortage of railroad freight cars exists in Los Angeles today and this condition is prevalent throughout the United States. It is singularly interesting that a railroad company that owns a ranch in Ventura County, near Los Angeles, is using the Advance Company's Pierce-Arrows to transport freight to relieve the pressure for rolling stock on its own lines.

This is a forceful lesson as to the actual situation in railroad transportation today, and it proves most clearly the value of truck service because of its economy, flexibility and freedom from congestion difficulties.

Garford Truck Hauls Big Guns Seven Miles

"Somewhere on the coast," near San Francisco, the government faced a problem. It consisted of moving four 28-ft. guns, weighing 10 tons each, a distance of seven miles over roads so winding that it constituted a very difficult and delicate

FLEET OF PEERLESS TRUCKS CARRYING CRATED PASSENGER CARS FOR VAN CORTLANDT VEHICLE CORPORATION, NEW YORK CITY, FROM CLEVELAND TO NEW YORK, A DISTANCE OF 552 MILES. IN LESS TIME THAN IT TAKES BY EXPRESS.

U S MOTOR TRUCKS

Would You Trust These Purchasing Departments?

Many informed and efficient purchasing department have passed on the U. S. trucks and found them good.

That confidence has been made good by the subsequent service of the truck under hard conditions.

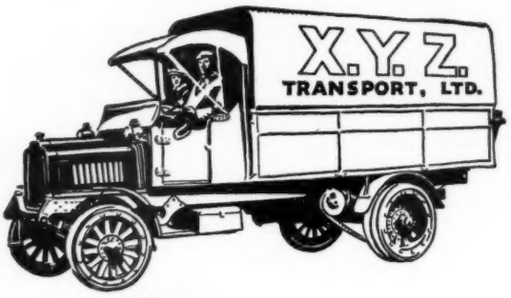
Would you trust the buyers for these concerns?

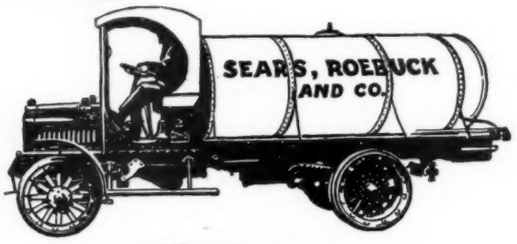
John Douglas Company
A. Kirschbaum Company
Sears, Roebuck & Co.
The American Oil Co.
X Y Z Transport, Ltd.
Keystone State Const. Co.
Union Iron and Steel Company

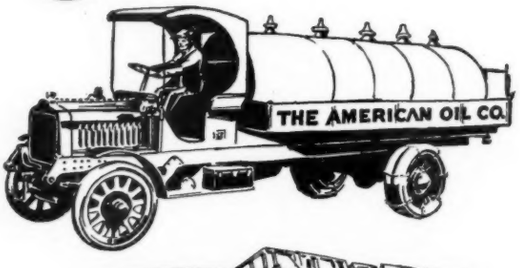
U. S. Trucks will prove as interesting to you as they did to these companies.

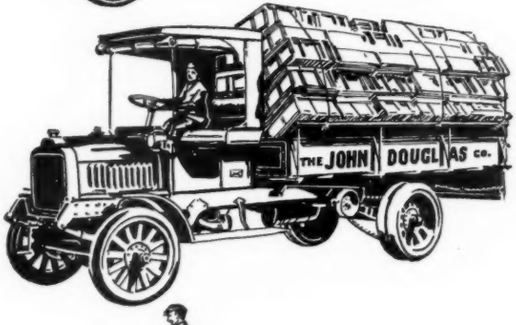
Worm-Drive—2½, 3½ and 5 ton.
Chain-Drive—2½ and 3½ ton.

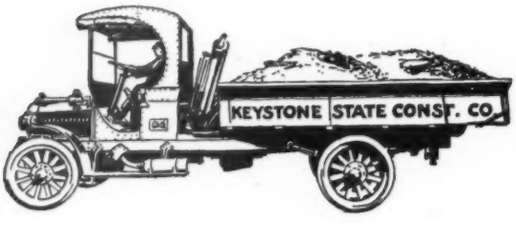
THE UNITED STATES MOTOR TRUCK Co.
CINCINNATI

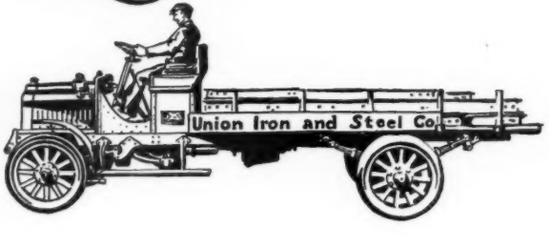












DUPLEX TRUCK AND TRAILER CARRYING TWO-PASSENGER CARS FROM LANSING, MICHIGAN, TO NORTH TONAWANDA, N. Y., A DISTANCE OF 465 MILES IN 35 HOURS.

MACK 2½-TON TRUCK AS OPERATED BY A. F. KROMP, SCHENECTADY, N. Y., ON REGULAR ROUTE BETWEEN ALBANY, SCHENECTADY, AMSTERDAM, JOHNSTOWN AND GLOVERSVILLE.

undertaking. Several hauling contractors gave it up, but the King Drayage Company agreed to tackle the job with a standard Garford 5-ton truck.

In describing the accomplishment of this feat, W. H. Sickenger, California manager for the Garford Motor Truck Company, states: "The haul was from the beach in sand varying from 3 to 9 ins. in depth, over a very winding road to the highway. This could only be negotiated by a short wheelbase truck like the Garford on account of the turns, and even so at times the front of the truck and the end of the gun were rubbing the bank.

"The haul took five hours to the gun. The removal of the four guns, which had formerly required four days with three times the equipment, occupied but two days."

Interstate Haulage with Armleder Trucks

Cargen Brothers, of Philadelphia, engage in intercity and interstate haulage with Armleder motor trucks.

They are running their three 3½-ton trucks backward and forward between Philadelphia and New York City about three times a week. They usually carry 4 tons to a load. They make a business of hauling general merchandise, and have lately been doing quite extensive business with the John B. Stetson Company, hauling Stetson hats on their truck and trailer.

The actual running distance between Philadelphia and New York is close to 100 miles, and their trucks make the trip in about eight hours. During the severe weather which we had this winter, when deep snow lay on the ground, Cargen Bros.' trucks never missed their regular weekly trips backward and forward between Philadelphia and New York.

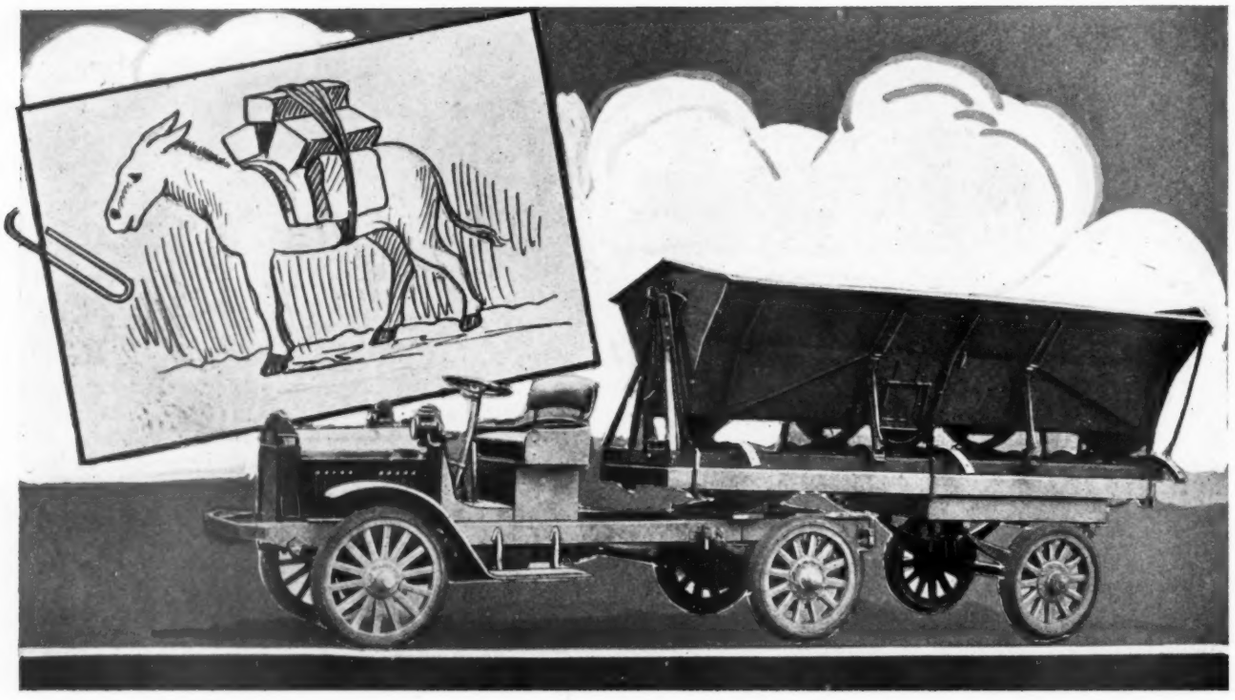
Cargen Bros. have a receiving station in Philadelphia which is very similar to a regular freight loading platform, and customers having numerous small packages to be shipped to New York deposit their merchandise at the receiving station, just as they would take it to the express office. There is also a receiving station in New York City and they have a man there who is booking return loads. In this manner their trips from Philadelphia to New York become a profitable proposition.

Cargen Bros. state that their gasoline consumption is surprisingly low, and they are very well pleased with the steady all-year-around service which their trucks have been giving them. At the present time they are running three 3½-ton Armleders, and expect to put on another one in the near future.

Acme Trucks on Long Hauls

V. E. Davis, of Ekalaka, Mont., has a 2-ton Acme in service. This truck is in operation on a regular schedule between Baker and Ekalaka, Mont., a distance of 42 miles. A round trip of 84 miles is covered in half a day with full capacity load.

MACK 7½-TON TRUCK AS OPERATED BY THE R. W. WALKER LUMBER CO., SALISBURY, NORTH CAROLINA, IN HAULING LOGS TO MILL.



Would You Go Back— To The Pack Mule?

"WE ATTACH our Columbia semi-trailer to our Columbia 2-ton truck and we have a 6-wheel 6-ton truck. That's how we get 6-ton performance out of a 2-ton truck, and the only difference between the cost of the Columbia 2-ton truck and the 6-wheel 6-ton combination is the small cost of the Columbia semi-trailer. Would we go back to the pack-mule? We would not. Neither would we pile the freight on the locomotive."

Columbia Trailer Combinations will enable you to haul three tons to every ton you hauled before and at no increase in operating costs. **Columbia** Trailers are ***tripling the capacity*** of motor trucks—are eliminating necessity of purchasing extra trucks and saving the wages of these additional drivers!

We make a full line of Trailers (all Types, for every purpose) in capacities from one to ten tons. The six-ton trailer is priced at $760. The six-ton combination (including **Columbia** two-ton tractor-truck) is priced at $2750. **Columbia** trailer and semi-trailer units will be shipped with your **Columbia** trucks or tractor-trucks. No delays. The **Columbia** two-ton truck ($1990) is oversize in every part.

Columbia Trucks and Trailers are guaranteed for one year from date of purchase. Immediate deliveries.

Valuable territory still open.

Columbia Motor Truck & Trailer Co.
PONTIAC MICH.

G. M. C. 1½-TON TRUCK, WITH CAPACITY LOAD, FIRST TO MAKE TRIP FROM SEATTLE TO NEW YORK. RUNNING TIME 31 DAYS.

Wheat, household goods, furniture and goods of almost every description are carried quickly and economically between these two points.

Frequently Davis makes trips from Baker to Boyes and Pinnele, Mont., a distance of 115 miles. While the roads are in very poor condition, this truck has carried a load of 4,500 lbs. of tombstone and a large heavy piano over this 115-mile route in record time.

J. R. Blanchard & Son, of Grand Meadow, Minn., operate two 2-ton Acmes. These trucks have been loaded with seven big sections of concrete drain tile, each tile weighing 747 lbs., making a total net weight of 5,229 lbs. These trucks carry this enormous weight at a speed of 18 to 20 miles per hour without any overexertion on the engine or any other parts of the machine.

On this hauling the roads were fair and the distance 5 miles. The trucks each made ten round trips per day, while a team could make only two trips. The trucks operated from 7 a. m. to 6 p. m. Drivers were paid $3 per day. The average load was 5,200 lbs. Cost of gasoline per truck per day, $3.30; oil, 40 cts.; grease, 50 cts. per month. Total operating cost per day for two trucks, $14.40. Mileage per truck per day, 100; cost per mile per truck, 4½ cts. Twenty-four horses and nine men were replaced by the two trucks.

Teamsters were paid $2 per day from 7 a. m. to 6 p. m. Each team hauled 2 tons and there were 12 teams. Cost of feed, $1.75 per team per day; cost of shoes, $4 per team per month; cost of harness repairs, $1 per team per month; total cost, $46 per 12 teams per day. Entire daily mileage, 240; cost per mile by teams, 18 cts.

Duplex Trucks Supersede Mule Pack Trains

Out on the great western plains hundreds and thousands of herds of sheep browse from May to November. But during the remaining months fodder must be brought to them, and the pack train has represented the only mode of conveying the fodder and supplies from the nearest town or railroad to the herd.

Naturally, the pack train was a slow and costly method. The carrying capacity of ten mules or horses, usually constituting the train, was of necessity extremely limited, and the 50 or 100-mile trip was attended with no small expense, in addition to the natural hazards and privations.

It was something of an experiment when the first Duplex truck was put into operation for this work. The condition of the country renders the operation of any vehicle extremely difficult, and it was a question whether the truck would be able to surmount the many obstacles which desert and mountain presented to motor vehicle operation. But the truck proved equal to the task.

The success of the first Duplex was so convincing that others were very soon requisitioned. The economy of trucks

G. M. C. 1½-TON TRUCK THAT RAN, FULLY LOADED, FROM SEATTLE TO NEW YORK IN 31 DAYS AND RETURNED VIA LOS ANGELES, SAN FRANCISCO AND PORTLAND TO SEATTLE.

900,000 Tons of Hauling Power Lost by Motor Trucks Each Day

WARNER TRAILERS UTILIZE THIS WASTED POWER

Transportation authorities agree that, in America, a minimum of 900,000 tons daily are moved by motor trucks. And power sufficient to move an equal tonnage is permitted to go to waste.

All good motor trucks develop an excess of power. When loaded to rated capacity they can easily pull another load at least equal to the one they carry. When the truck is used alone this power is lost. But with **Warner Trailers,** motor trucks work at full capacity. And the cost of operating truck and trailer together is only slightly above that of running the truck alone. This, with a far more efficient method of hauling.

Your Truck Driver Operates the Warner Trailer

With Warner Trailers hauling costs show a gratifying decrease. The three greatest items of expense—labor, motor upkeep and gasoline—are cut in half.

Hitching and unhitching the trailers is a simple matter. One man—the driver—does this in a minute's time. And Warner Trailers follow the trucks without further attention.

Other Advantages

Warner Trailers not only cut hauling costs, but they offer a far speedier delivery service than is possible with trucks alone. One instance of this: The Warner Trailer can be dropped at one point for unloading; the truck proceeds to another to discharge its own load, and the empty trailer be picked up on the return trip. This keeps the power plant working almost continually. In countless other ways Warner Trailers make for economical, efficient delivers service.

Built Like a Motor Truck

Warner Trailers are of sturdiest construction throughout. Built like a motor truck minus the power plant.

Don't confuse the Warner Trailer with a wagon simply because it trails. This is a high speed, mechanically correct appliance. Many exclusive features increase efficiency. Warner Trailers follow the trucks around corners, into alleys or narrow loading spaces. Reversible so they can be hitched or steered from either end. Easily backed.

An Exclusive Warner Feature

Our universal Ball and Socket Hitch. No coupling pins. Operates like your shoulder joint. Allows for every conceivable position of the truck and trailer. Eliminates all binding strain in going over bumps, around corners or when truck is going up hill and trailer coming down, even at extreme angle.

Endorsed by Big Business

America's largest contractors, public service corporations and manufacturers are users of Warner Trailers. These concerns did not adopt them on unsubstantiated claims or without investigation. Their transportation engineers made a thorough study of Warner Trailers and their value in solving hauling problems.

A similar investigation will benefit you. We have more interesting facts on trailer hauling to lay before you. Write to us today for further information.

WARNER MANUFACTURING COMPANY

116 Bushnell Avenue **BELOIT, WISCONSIN**

Inter-city Freight in the future will be largely handled by motor. Warner Trailers make possible the truck trains necessary to such service.

WARNER HEAVY DUTY TRUCK TRAILERS TWO AND FOUR WHEEL TYPES

GENERAL MOTORS TRUCK AND SEMI-TRAILER AS OPERATED IN TRUCKING TIMBER IN THE NORTHWEST.

compared with pack trains is very evident. It is a comparatively easy matter for a truck to haul an amount at each trip equal to that carried by two or three pack trains—20 to 30 horses or mules. The saving in time, too, is no inconsiderable factor. A 100-mile trip for a pack train meant four or five days on the average, whereas a Duplex truck will make it in two. A large number of Duplex trucks are now in this service, hauling fodder and supplies to the points where the herds are located, and bringing loads of wool on the return trips.

Pierce-Arrow Trucks Relieve Freight Congestion

On long hauls there are scores of cases in which Pierce-Arrow trucks are more than meeting every demand. For instance, daily deliveries between New York and Philadelphia, 180 miles round trip, are maintained by the United Gas Improvement Company, Pennsylvania Silk Dyeing and Finishing Company, Millers' North Broad Street Storage and Warehouse Company, A. T. Baker Company, Lippincott's, and others, saving time and money, relieving congestion and keping uninterrupted the flow of communication.

The Westfield Storage Warehouse, at Westfield, N. J., is delivering regularly to a dozen Connecticut towns, as distant as Hartford (240 miles); to as many New York State towns, as distant as Troy (208 miles); to as many Pennsylvania towns, as distant as Allentown (180 miles); to as many New Jersey towns, as near by as Haddonfield (80 miles). In other words, these trucks are operating in four states over a 360-mile diameter, economically and profitably.

The Mt. Hope Finishing Company, of North Dighton, Mass., gets material in two hours from Fall River, 12 miles away, which formerly required four days by freight—when they could get the cars—or in three hours from New Bedford, 25 miles away, which frequently required 10 days. The saving of water transportation instead of rail was insignificant compared to the importance of steady supply.

Cleveland-Akron Bag Company Uses Trucks for Intercity Haulage

The brick roads surrounding Cleveland place it in the center of an easy delivery service that can reach out in every direction from Conneaut, Ohio, on the northeast to Sandusky on the west and Canton on the south. A circle drawn through these cities with Cleveland as the center, circumscribes Warren, Youngstown, Salem, Canton, Massillon, Norwalk, Oberlin and all the towns on the main thoroughfares within the territory described.

In 1917 the Cleveland-Akron Bag Company maintained a regular service over part of the territory described, and the results were so satisfactory to the patrons of the company and to the company itself that it is their purpose to enlarge the scope of the delivery in 1918 and to take full advantage of the opportunity offered by the roads to operate a fleet of 52 trucks.

The actual operation of this truck transportation in 1917 showed that, with care and foresight in loading and arranging deliveries, goods can be placed at the buyers' doors within this territory at a cost less than that of express shipments to the same points. Besides the saving in cost of transportation,

PACKARD TRUCKS, LOADED WITH CRATED PASSENGER CARS, READY TO BEGIN 580-MILE JOURNEY OVER THE HIGHWAYS TO BALTIMORE.

there is the satisfaction of buyer and seller alike in knowing that the goods are actually on the wagon and will be delivered at the door within the hour.

Maxwell Motor Freight Line Between Detroit and Chicago

To Harry Newman goes the credit of establishing the first motor freight line between Detroit and Chicago, a distance of 296 miles by a road log.

Unique in plan and picturesque in its appearance, this caravan, which was composed of 53 Maxwell 1-ton trucks, upon which were mounted 53 Maxwell passenger cars, arrived in Chicago Dec. 26, 1917, at 2:14 p. m.

This is the largest shipment of automobiles ever received in Chicago under the direction of one man on an overland drive, and the total of 106 automobiles were driven through in perfect condition, credit for which is given to Ray McNamara, the famous road driver, who has established many records for the Maxwell car, and who piloted this enormous "motor freighter" from Detroit to Chicago in absolute safety.

The reason for the establishment of this motor freighting transportation between Detroit and Chicago was not only on account of the shortage of freight cars, but also to prove to the people in general that motor freight lines are the latest and most efficient method of transportation.

The mere fact that the Maxwell trucks came through in such fine condition conclusively proves that the light and economical Maxwell 1-ton truck, with the Timken worm gear, can stand the rack and abuse of being pounded on country roads for an unlimited number of miles.

Air-O-Flex Truck in Parcel Post Service

"Some idea of the future of the motor truck in the carrying of parcel post packages of every character may be gained from the successful operation of one truck in eastern parcel post service," said F. W. Schwerdtfeger, chief designing engineer of the Air-O-Flex Automobile Corporation, of Detroit, recently. "This truck has earned $30 per day for the government in carrying parcel post packages on a route from Philadelphia to Oxford and return, a distance of 100 miles, made daily. It is not hard to estimate the earning powers annually of this truck. The figures show $10,000 per year, and the operating expenses are stated to be $4,200. This will give an insight into the future of trucks. This truck in Pennsylvania carried a representative load on one trip of 180 miles into New York City, recently. Its produce included 50 cases of fresh eggs, 200 lbs. of honey, 500 lbs. of butter and 1,000 newly hatched chickens."

Dump Truck Powered with Wisconsin Motors

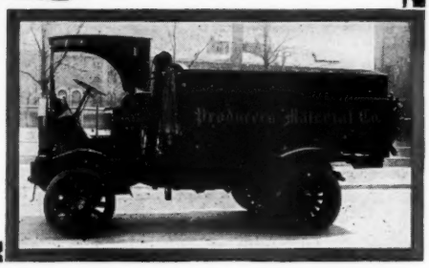
CONSISTENT

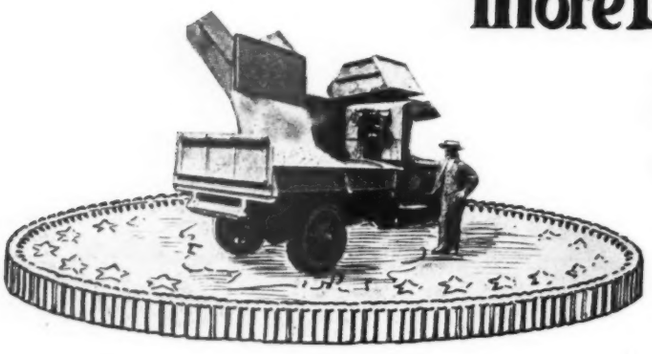
The standard power for municipal trucks

Write for specifications on different types and sizes.

WISCONSIN MOTOR MFG. CO.
Station A. Dept. 330
MILWAUKEE, WIS.

New York Branch,
21 Park Row,
T. M. FENNER, Factory Rep.





"More Loading On Less Cost"

Frank McInnery
Easton, Pa.

Heltzel Lightning Loader Skips

are winning battles against demurrage charges. They'll enable you to "do your bit" and *save you money*—that's economy! And patriotism, too!

"Easier for shovelers with the Heltzel Lightning Loader," says Tilgham H. Moyer, Contractor, Allentown, Pa. "The men keep more *steadily at work* because less energy is needed to keep the pace than with the old methods. Our two Heltzel Loaders fill a three-ton truck in two minutes. Beats hand shoveling by nine to ten minutes easily!

"Our Heltzels keep shovelers, trucks and drivers *steadily* on the move. Make most of minutes all along the line."

One of many cases where Heltzels are more than paying for themselves by their dependable *every-day* savings. They'll do the same for *you!*

Ask us How!

Heltzel Steel Form & Iron Co.
WARREN, OHIO.

MASTER TRUCKS

"FAST 12-hour runs over all kinds of roads, with 50% overloads, from the power and endurance of

MASTER TRUCKS

"Pulling through sand, almost up to the axles, without changing gears or boiling water in the radiator, is real—**Master**—performance."

Not a single unit of experimental or unknown quality enters into the **Master** line. Every weakness of truck construction has been eliminated and every required strength intensified, regardless of cost or custom.

The price of the **Master** 2-ton chassis is $2290; 6-ton tractor, including **Master** fifth wheel, $2550; 3½-ton worm drive, $3690—f.o.b. Chicago, plus 3 per cent war tax. Immediate deliveries guaranteed.

MASTER TRUCKS, Inc.

3145 South Wabash Ave. **CHICAGO, U.S.A.**

DESIGNED BY MASTERS---BUILT BY MASTERS

The Transportation Problem

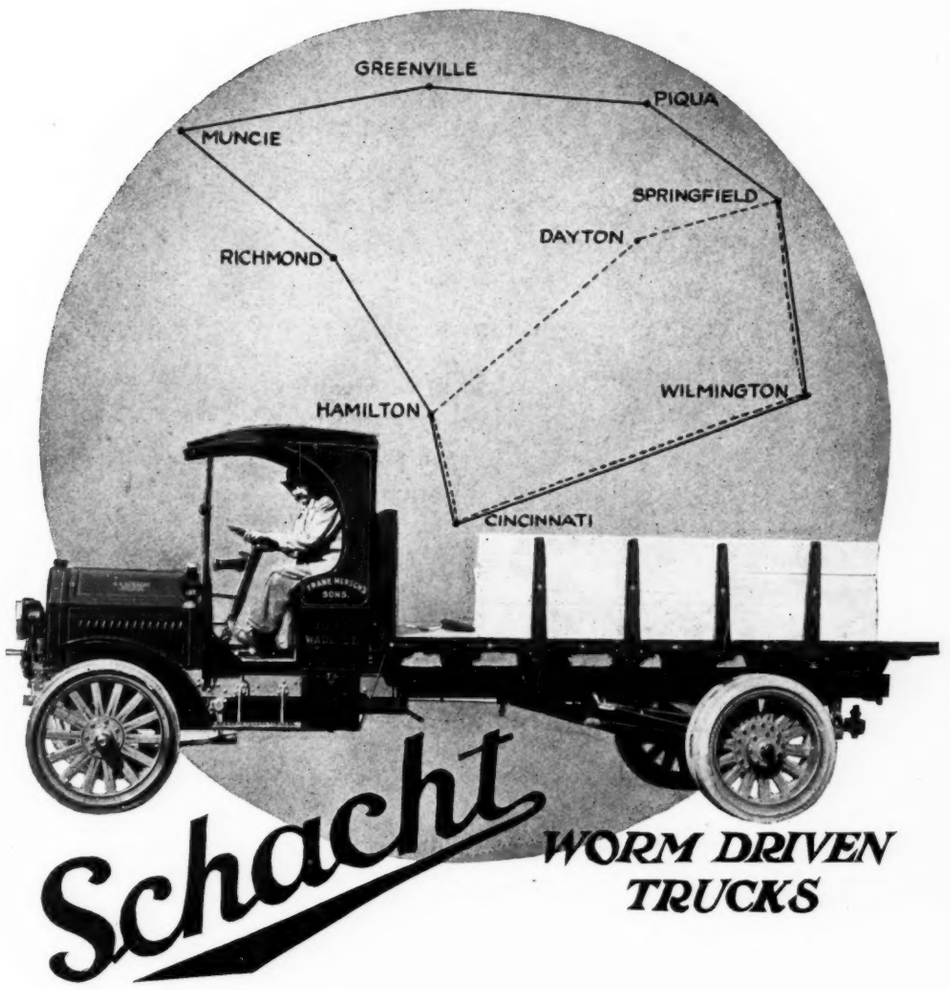
THE Railroads *must* be relieved—Goods *must* be moved—The wheels of industry *must* be kept moving—

The solution of the problem lies in the use of Motor Trucks for all hauls of one hundred miles or less—Wilson Transportation Engineers will help you in the adaptation of Wilson Trucks to *your* transportation needs.

Wilson Trucks are the product of more than thirty-five years experience in the building of heavy duty transportation vehicles. One, two, three and one-half, and five-ton worm-drive models.

We can use a few more dependable dealers in Eastern and Mid-Western Territory

J. C. WILSON COMPANY, Detroit



"Schacht 3½-ton Trucks Transport our fast freight direct to customers in surrounding cities

"All roads are **Schacht** roads and all distances are **Schacht** distances—we are not subject to any traffic delays or embargoes. No matter how steep the hills or 'rutty' the roads, our **Schachts** always finish on schedule time." **Schacht** trucks are made (not assembled) in the **Schacht** plant, and the **Schacht** Sales Plan includes generous discounts, liberal treatment and strong co-operation. If it's trucks, write **Schacht.**

Immediate Delivery

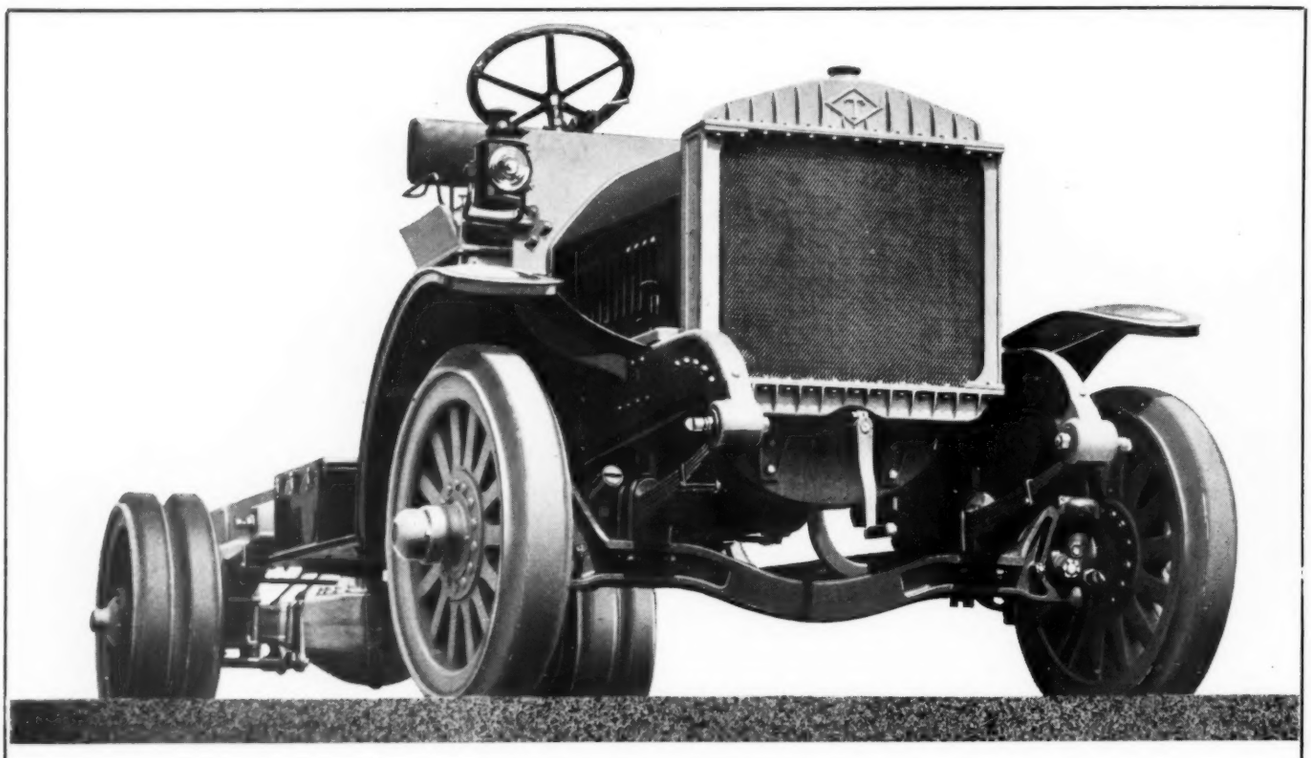
The G. A. Schacht Motor Truck Company

Factory and Main Office, Cincinnati, Ohio.

Chicago Branch:
2422 Cottage Grove Avenue

New York Branch:
422 East 54th Street

2, 2½, 3½ and 5-ton capacities.



DIAMOND T
TRUCKS

"THE Diamond T Truck purchased from you over three years ago has given us very satisfactory service. We have used this truck daily since its purchase and we feel sure, considering the heavy nature of the material we haul, that it is the equal of any truck on the market of this capacity" —the opinion of the Garden City Sand Co., which is practically the same as the opinion of nearly every user of Diamond T Trucks.

The basic reason for this general satisfaction is the use of standardized units in the construction of the Diamond T Truck.

By augmenting the efforts of our highly efficient engineering force with the best engineering brains of the motor truck industry, we have effected a combination that has proven exceptionally satisfactory.

WHEN you purchase a Diamond T Truck you purchase the maximum insurance against dissatisfaction and mechanical difficulties.

Economy is yours—from the initial cost on. Efficient service, minimum upkeep and low operating cost are features of the Diamond T—and they are proven by the fact that ***no Diamond T has ever worn out.***

There is a model of a Diamond T for every delivery need. Five standard models of the highest type—capacities from one to five tons.

Before you make your truck purchase it will be worth your while to see the Diamond T dealer in your territory who will explain all of the superior qualities to you—or if you prefer, write us for specifications. Increased factory facilities enable us to make ***prompt deliveries.***

Diamond T Motor Car Company

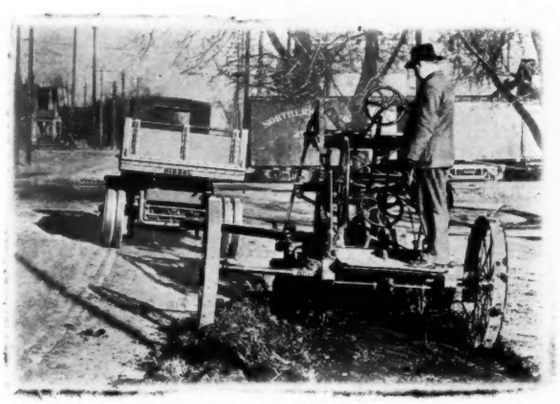
Factory and General Office,

4505 West 26th Street **CHICAGO, ILL., U. S. A.**

Building the Nation's Highways with Kissel Trucks

IN different parts of the country Kissel Trucks are answering the nation's cry for more good roads—

Municipalities—contractors—road builders—find in Kissel Trucks a super-abundance of power and strength necessary in getting contracts finished on schedule time.



Investigate the exclusive Kissel combination of Kissel-built power-plant, perfected worm-drive rear axle, heavy duty front axle, special heat-treated frame, over-size brakes and springs.

Send for data on Kissel Truck performance in road building. Or see nearest Kissel dealer.

KISSEL MOTOR CAR COMPANY, Hartford, Wisconsin, U.S.A.

BALANCE

Advanced Design! Sound engineering principles! Accompained by the utmost care and skill in the shops! Nicety of fit and exact co-ordination of all parts! That's your assurance that a HALL truck cannot burn up useless gasoline money as does the ordinary truck. The mechanical arrangement of a HALL truck is perfectly *balanced;* it works as smoothly as a perfect watch—all because it has back of it years of unflinching, tedious experiments to produce a stronger, *better balanced* truck that would reach a maximum of *economy* with a maximum of mechanical *efficiency* and All-Year-Round Service.

HALL Trucks are free from vibration, rattle, stress and strain—there is no slippage, skidding or spinning of the rear wheels because maximum traction is secured thru proper distribution of load. Just another reason why you should "Haul it in a HALL."

THE LEWIS-HALL IRON WORKS

Manufacturers of the HALL Truck
(Established 1873)

Ferry Avenue and Grand Trunk Ry. **DETROIT, MICH.**

New York Distributors: R. D. King Motors Co., Inc., 9 Central Park West, New York City, Metropolitan Dealers.
New England Distributors: Hall Motor Truck Co. of N. E., 1123 Commonwealth Ave., Boston, Mass.
Guarantee Automobile Exchange, 629-31 N. Broad St., Philadelphia, Pa., Philadelphia Dealers.

EDITORIALS

Individual Merit of Proposed Public Improvements

Workers in the construction field will do well to grasp the fundamental principle in the attitude of officials of the Federal government toward making public improvements in war times. That principle, as we understand it, is that where a proposed improvement will aid in winning the war, or is clearly called for on economic grounds, it should be made; conversely, if an improvement will not aid in waging and winning the war or is not a clear economic necessity, it should not be made at this time.

Our understanding is based directly upon correspondence with officials of the Treasury Department. In a letter to the Secretary of the Treasury we recited that in our efforts to interpret the attitude of the Federal government relative to the construction of hard-surfaced roads we were so often thrown into confusion by conflicting press reports that we were moved to put this question to him direct: "Precisely what is your attitude at this time towards the construction of hard-surfaced roadways for utilitarian purposes?"

On direct instructions from the secretary his position was stated as follows: "Congress having passed the War Finance Corporation Bill providing for a Capital Issues Committee, there will be appointed in the near future (after April 5, the date of the letter) a group of men, which will be prepared to advise authoritatively concerning each individual case that may be brought to the attention of the committee. In the past the general principle upon which the committee has been proceeding has been that unless a military necessity exists, or there is a clear economic necessity, bond issues for road building should be postponed at this time. As stated above, however, each case will be examined on its individual merits, and it is very difficult to apply a satisfactory general rule."

It should be accepted without question that the construction industries are in the hands of loyal men. They, like all other right-minded Americans, want to conserve the nation's capital and resources, while increasing the production of wealth, and they also wish to encourage thrift. **But,** they should not be so foolishly unselfish as to prejudge their own projects to their own disadvantage. That is not loyalty; it is weakness. It may be downright disloyalty for those who best understand the value of good roads, for example, to cease working on road projects when they believe those projects are essential to the best interests of the nation at this time. Such projects should be pushed now more energetically than ever before, for never was the need for good roads so great as it is now.

While conceding to the Federal officials the desire to let business go on, there is no use ignoring the known fact that these officials are not omniscient. They understand some business relations better than others and they follow certain economic lines of influence more closely than others. Thus, while clearly appreciating the importance of railway transportation, there is no strong demonstrated reason for supposing that the officials of the Treasury Department have an at all adequate understanding of the value of highway transportation. It is for those who do appreciate the military and economic importance of hard-surfaced roads to work for these improvements without ceasing, for they can render no greater service than this to the nation at war.

In working for individual road improvement projects of genuine merit, for example, the worker may rest assured that he is not biased; others have reviewed the merits of such cases and have reached the same conclusions as himself. Thus, a recent canvass of the business men of the United States shows practically a unanimous belief that highway improvement is an economic and war necessity and that construction should proceed if the highways are to meet the traffic requirements of the country. Business men, generally, understand that it is a physical impossibility to expand the railway facilities rapidly enough to solve the transportation problem. The only hope of handling the freight of the country lies in the rapid development of highway transportation facilities. Obvious as this is to engineers, contractors and others who have long been familiar with the elements of the problem, officials at Washington simply do not appreciate the importance of highway transportation. If they did they would urge road improvements instead of merely granting their approval of individual projects.

Months ago the Chamber of Commerce of the United States endorsed road building as an economic and military necessity and at the latest meeting of that body the same interest was expressed in the development of highway transportation as a means of supplementing the railways. The popular press has been insistent in its demands that freight congestion be prevented, or at least relieved, by the transportation of freight by motor trucks over the highways. Men in the construction industries, therefore, need not hesitate to speak up for what they are in position to do for their country, for their services are wanted and their works are approved by their best informed fellow citizens. In this, as in some other matters, the administration officials are lagging behind public opinion. But, just as the officials have shown their ability to adopt the public viewpoint on other matters, so will they come to appreciate the wealth-producing qualities of certain public improvements if the educational process is sufficiently prolonged.

Very recently Secretary McAdoo said: "The successful financing of the war depends upon the difference between what is made and what is spent." There is no known way of adding to the public wealth that produces wealth any faster than the installation of improvement projects of high individual merit. Such improvements immediately begin to yield dividends to the public. The secretary has formulated a correct economic principle. Let us help him to see that a good application of the principle lies in the construction of improvements of merit. There should be no hesitancy in asking the Capital Issues Committee to pass on such improvements. It is our belief that the committee will act favorably.

Construction Costs After Other Great War Periods

Some local authorities are backward in initiating desirable improvements on account of present high construction costs. So far such authorities have thought only of present costs in comparison with those of recent years. They will do well to compare them with the probable costs of years in the near future. In this they may well be guided by considering construction costs in former periods following great wars involving many nations.

In the period of great wars covered by the French Revolution, the Napoleonic wars and the second family quarrel between this and the mother country, all the great nations were engaged in war. Students of economics and history assure us that during that period of approximately a century ago prices showed the same characteristics as during the present greatly disturbed period. All raw materials rose rapidly in price. Prices continually advanced until the end of the war in 1815. Then for about a year there was a sharp price reduction. This factor, added to the natural accumulation of work, again started prices upward, until they reached practically the maximum prices of the war, where they remained for about five years.

The same authorities state that during the series of wars including the American Civil War, the Crimean War, the Austro-Prussian War and the Franco-Prussian War, prices practically duplicated their behavior of the earlier period. Prices reached their highest level in 1874, three years after the close of the Franco-Prussian War, and did not return to normal until 1880.

In view of the foregoing facts public officials may well doubt the wisdom of postponing the installation of desirable improvements because of present high costs. Prices will hardly return to the pre-war level for a decade after the war. An improvement needed now cannot be postponed for a decade without public loss. Unless some other consideration than present prices is raised, therefore, there is no reason for deferring work of this sort.

Wheatless Days and Undrained Acres

At a time when the Food Administration is asking all citizens to observe wheatless days, and when efforts are being made to stimulate the production of wheat, it will come as a shock to many to learn of the vast acreage of lands lying idle or producing to poor advantage because of the lack of adequate drainage facilities. Citizens undoubtedly favor wheat conservation and wheatless days are observed cheerfully as a part of the individual contribution to the winning of the war, but citizens have a right to expect that the government will do its full part to increase production at the same time. This the government is not doing. It is quite as important to increase wheat production by reclaiming waste lands as to increase it at the expense of useful meadow and pasture lands and lands normally devoted to other crops.

In this issue we publish an authoritative article which states that construction work on drainage projects has been retarded by lack of equipment, material, supplies and labor, and that unless those in charge of drainage projects bestir themselves to obtain the desired assistance from the federal government, the outlook for land drainage for 1918, and probably for the next ten years, will be dismal.

The author states that the drainage situation is very alarming. It is the duty of engineers and others who understand the situation to present the merits of the land drainage case to the proper federal authorities and agencies. Engineers can make no greater contribution than this to the winning of the war, if there is truth in the slogan: Food Will Win the War.

How important this matter is will be at once appreciated when one learns that in 1910 there were 150,000,000 acres of tilled lands that were only 20 per cent. efficient because of poor drainage. In addition to this, there are about 80,000,000 acres of swamp and overflowed land in this country that are totally unproductive because undrained. A large part of this land could be made highly productive in a short time and at comparatively small expense.

Those who are informed in all the premises should use their influence on the Department of Agriculture, looking to the prompt and correct solution of this highly important war problem.

An Example of First-Class Engineering

The sort of engineering that grips the imagination while appealing also to technical interest, and, at the same time, shows what the professional engineer can accomplish when he adopts the aggressive methods of the progressive business man, is described in the article published in this issue, entitled, "Design and Construction of the New Municipal Dam and Hydro-Electric Power Plant at Fort Dodge, Ia."

The article is good from the technical standpoint, but certain features of the project and the methods employed in promoting it are of such unusual interest as to merit special comment.

The dam was built, first, to produce money from the sale of electric energy generated by water power, and, second, to create a lake to be utilized by the citizens for pleasure purposes. Undoubtedly the appeal of the second consideration to the taxpayer was what made the project possible of accomplishment. To an inland community like Fort Dodge the prospect of obtaining at home a lake for fishing, boating and bathing proved very attractive, as one can readily understand. That the project was fully justified from the financial standpoint is also at once evident from the fact that private interests sought franchise rights for its execution.

The engineers took a leading part in the campaign preceding the necessary bond election. They transferred their preliminary sketch plans, estimates and other data to lantern slides, which were shown and explained at mass meetings. This procedure acquainted the citizens with the merits of the project, appealed to the public imagination, and enabled the taxpayer to cast his vote intelligently. The result, easily anticipated, was the success of the bond election.

The engineer reader will not fail to note with appreciation the frankness with which the author discusses the difficulties encountered with floating ice shortly after the spillway section of the dam was finished. The methods successfully employed in overcoming the difficult situation thus produced, add to the article just the spice necessary to lift it above the level of the commonplace. Rarely does an article show modern engineering in a better light.

PAVEMENT DESIGN AND CONSTRUCTION

The Design and Construction of a Granite Block Pavement

By George W. Tillson, Consulting Engineer, Brooklyn, N. Y.

It is undoubtedly true that in the past highway engineering has been given less attention, according to its worth, than any other branch of the profession. Engineers have been prone to think that a pavement is a pavement, and no matter under what conditions it was to be used, to consider that any one material should always be treated in the same manner.

Tradition Long Arrested Development of Granite Block Pavements

This can be illustrated most clearly in the case of granite pavements. When first used the blocks were approximately 8 to 14 ins. long, 3½ to 4½ ins. wide and 7 to 8 ins. deep. These were laid on a sand base with the joints filled with sand. It was soon found that such a pavement would not maintain its surface under heavy traffic and a concrete base was substituted for the sand, the joints between the blocks were filled with tar and gravel, but the dimensions of the blocks were not changed.

A little thought should have made it evident that the large, heavy blocks used for stability on a sand base were not necessary on concrete and that the depth of 8 or even 7 in. was not required, as the blocks very seldom wore down to any great extent, but rounded off and so became too rough for use.

The writer feels free to make the above criticism as for 35 years he has been engaged in highway and street work and thinks that the remarks apply to himself as much, if not more, than to any one else.

But in recent years a change has come over the minds of engineers and they have recognized that the public not only demanded a better granite pavement, but was willing to pay for it. And it must be admitted that question of cost also has seriously retarded the progressive movement.

The advent of the automobile and the auto truck soon showed the necessity of a different construction on country roads and the study of those requirements naturally lead up to the question of improving city streets. Granite pavements have been unpopular because they were rough and noisy, and as they became more rough they naturally became more noisy. One phase of the question then was to make the pavement smoother.

Sherrerd Pioneered for Improved Granite Pavements

The one man to whom the most credit should be given for starting a movement for a better granite pavement is without doubt Mr. M. R. Sherrerd, Chief Engineer of the Department of Public Works, Newark, N. J. At his suggestion a meeting was called in New York City in 1909 composed of many highway engineers in the East and the manufacturers who produced the granite blocks used in that section.

The idea was not simply to specify a block that would make a good pavement. That would have been comparatively easy. But what was desired was to decribe such a block and have it also one that *could* and *would be* furnished at a reasonable price.

Advantages of Standard Sizes

Another thought was that if the engineers of New York, Philadelphia, Boston and Newark could all agree upon a standard specification so that the same blocks could be used in any of these cities the problem would be much simpler for the manufacturer and the result just as good if not better for the cities themselves. At that time no two of the above-mentioned cities were using blocks of the same size. So that when a hurry-up call came from any one city for an extra amount of blocks, it often could not be supplied, although the manufacturer might have plenty of blocks that he could not dispose of on account of the size. The possibility of the interchange of blocks between the different cities is of great value. Then, too, it is much better for the block cutters themselves to know that they are making one style of blocks all the time. It adds greatly to their efficiency and consequently to their wages, as they always work by the piece.

This New York meeting was quite fully attended and very harmonious. The manufacturers recognized that if a better granite pavement was produced it would very much increase its popularity, which had been on the wane since the introduction of asphalt and other smooth pavements. The manufacturers brought out the point, which had not been fully appreciated by the engineers, that if the blocks were made smaller, that is no larger than the demands of traffic required, they could be made smoother much more easily and with less labor. It is a fact also that the smaller the individual unit in any mass, the smoother will be the resulting mass. To show this by extremes one need only compare a surface composed of irregular sized cobble stones with one of fine sand. But in a pavement the minimum size that will satisfy traffic should be permitted.

VIEW OF NEW GRANITE BLOCK PAVEMENT ON BEDFORD AVE., BROOKLYN, SOUTH FROM ST. JOHNS PLACE.

The result of the meeting was highly satisfactory as it not only brought the producer and the consumer more closely in touch with each other, but it did unquestionably have a great influence in the character of granite pavements, which throughout the country have been much improved since that time.

As has been intimated the introduction of the improved granite pavements has been retarded by the extra cost even if that were not very great. Engineers as a rule do not have much to do with the appropriation of funds for street improvements except to recommend it. It took some time for city authorities to realize that the new pavement was worth its extra cost and that while at first it seemed more expensive it was really more economical in the long run on account of its greater durability. Practically all cities can afford to, and all should, build any structure with a view to its ultimate rather

than its first cost. This is especially true of a street pavement, which is constantly being used by the public to whom its constant tearing up for repair or renewal is a great nuisance.

Considerations Affecting Design

The possibility of variation in the specifications to meet requirements being recognized a study of these requirements becomes necessary. Before an architect plans a building he first makes himself conversant with the uses to which it is to be put. So, too, must the engineer study the requirements of a street to be paved. Once having determined upon granite as a material he must next decide as to just how this material is to be used. To do this intelligently he must know the amount and nature of the traffic the pavement will be called upon to sustain, understanding that a thousand units of 1 ton each will produce a different result than a hundred units of 10 tons each. Then, too, he must know whether the traffic will be steel or rubber tired, for if a tire of soft material be used so that the load produces a certain pressure rather than an attritive wear so that it might be necessary to provide an extra strong foundation rather than extra wearing block. As has been said before very few granite blocks actually wear down to a great extent and, therefore, a particularly hard block is not always required. They also are very seldom actually crushed by traffic. There are very few granites, if any, that will not stand present truck loads. A block that will wear down smoothly and evenly is very desirable and should be used, if easily obtainable, except on steel-tired, heavy traffic streets.

After the character of the granite itself, the items most to be considered and upon which engineering practice differs most at the present time are, dimensions of the blocks, how closely the blocks should be laid, character of the joint filling and whether the blocks shall be bedded in sand or in a mixture of sand and cement. It is understood that a base consisting of Portland cement concrete sufficiently strong to sustain the loads will be provided.

Present Standard Blocks

The size of blocks in the standard specifications for granite at the present time are: Length, 8 to 12 ins.; width, 3½ to 4½ ins., and depth, 4¾ to 5¼ ins. This is practically what was determined upon at the New York conference. The most important dimension is the depth, although width must be considered, especially if the pavement is to be laid upon an appreciable grade. A narrow block gives better foothold to horses and probably looks better, but it is doubtful if in any event the width should be less than 3 ins. and then only in exceptional cases. Whatever the width, it would be desirable to have all blocks the same, but that would entail considerable, and from a utility standpoint extra, expense. For that reason the 1-in. leeway is given in the width. The blocks, however, should be so sorted that those of equal size should be laid together.

The depth is important both because it must take care of whatever wear there is and because an unnecessary depth makes the cost more on account of freight charges. A lightweight block is also more easily and quickly handled by the paver.

In length a too short block makes many joints parallel to traffic, which is liable to undue wear no matter what the filler. One that is too long is liable to move under the wheel loads unless solidly bedded. A length of 8 or 9 ins. would probably be ideal, but the question of expense again comes up if the restriction is made too strong. A length of 8 to 12 ins. is generally satifactory.

Joint Width

How closely the blocks shall be laid or what the width of the joints shall be depends upon how well the blocks are made and the specifications generally state that they shall be so dressed as to lay with a certain joint width in the pavement. The old requirement when tar and gravel joints were used was for a ¾-in. joint, while now one of ⅜-in. is often called for. This difference of ⅜-in. calls for a much better block and produces a correspondingly better pavement.

Joint Filler

When granite blocks were first laid the joints were filled with sand, but when a concrete base was used gravel took the place of sand with coal tar poured into the voids of the gravel so as to make a water-tight joint. Later a grout made of equal parts of cement and sand was used, Worcester, Mass., probably being the first city to adopt this method. When the new blocks were adopted a bituminous filler was tried with good results and later still a mixture of sand and coal tar or asphalt.

While the intent of the tar and gravel filler was to produce a joint impervious to water, such a condition was not always obtained. The ¾-in. joint allowed the use of large sized gravel, making large interstices, which required great care to fill. If the gravel was reduced in size the interstices were liable to be so small that unless the filler was always hot the voids were not filled. This joint filling cost from 35 to 40cts. per yd. and the writer never felt that good value was received for the money.

The cement grout joint is satisfactory, where carefully made, as far as use is concerned, but when the pavement is taken up for any subsurface work many of the blocks are broken and after the restoration great care must be taken to keep traffic from it till the grout has had full time to set. In new work this same precaution must be taken, so that the opening of the street for use must be delayed for a considerable length of time after the pavement is finished. On the other hand the cement filler makes a continuous and complete surface and fills all the irregularities of the blocks. With blocks dressed for a ⅜-in. joint it is possible to use a pitch filler satisfactorily. With a large joint too much pitch would be required both from a financial and use standpoint. When a quiet pavement is desired pitch is most satisfactory as it prevents the noise from the wheel concussions being transmitted from block to block, thus making a continuous roar. Since, however, the adoption, to so great an extent, of auto trucks with their rubber tires this is not so important.

Some engineers use a mixture of equal parts of sand and pitch for two reasons: One to reduce the expense and the other to make the pitch more stable; that is, to have it change less with the changes of temperature. It undoubtedly accomplishes both. Mr. John Brodie, City Engineer of Liverpool, was probably the first engineer to use this combination in the application of bituminous material to broken stone surfaces.

Cushion

The first specifications for granite blocks on concrete called for a sand cushion. And as the blocks varied an inch in depth, in order to give them all a firm bed this cushion had to be 2 ins. thick, but when the new blocks were adopted it was possible to reduce this to 1 in. and sometimes less when the concrete was very smooth. As the only use of the cushion was to insure an even bearing to all blocks it was desirable to use simply what was necessary. More recently it has been the practice of some engineers to lay the blocks in a cushion of cement and sand, so that when this mixture had set the blocks would be absolutely solid with no possibility of any displacement by the movement of the cushion, which sometimes occurs when sand alone is used. The objection is that the entire pavement including the base is one monolithic structure, hard and solid with absolutely no resilience. The people favoring this practice do not think this objection is important, and in any event is more than compensated for in the increased durability of the pavement. If a cement joint filler is used the objection to the mortar bed can hardly be objected

to. With this bed great care must be exercised to have each block set firmly, solidly and evenly, so that the cement set may not afterward be disturbed.

The Bedford Ave. (Brooklyn) Granite Pavement

One of the best examples which the writer knows of where special care has been exercised in designing a pavement is the one now laid on Bedford avenue, Brooklyn, between Sterling Place and Eastern Parkway. This avenue is the great north and south street of the borough. It sustains a very heavy traffic of automobiles and auto trucks, practically all with rubber tires. It has a grade so steep that it was not deemed advisable to pave it with asphalt, but a smooth pavement was desired. It was paved in 1916 with special granite blocks set on a motar bed with cement grout joint. It has passed through two severe winters and the only cracks are small ones across the roadway at fairly regular intervals, probably due to contraction, marring slightly the appearance, but not at all interfering with the use of the pavement. The surface is exceedingly smooth, and as the writer had nothing to do with either its design or construction, he has no hesitation

OLD GRANITE BLOCKS, READY FOR REDRESSING, REMOVED FROM THIRD AVENUE, RECUT AND RELAID ACROSS CENTRAL PARK, NEW YORK CITY.

in saying that no better pavement for its use can be found anywhere. This pavement cost on a 6-in. concrete base, with no maintenance, but including the removal of the old pavement, $4.30 per sq. yd. Quotations are herewith given from the specifications that show the particular points emphasized in the construction.

The cost of repairs to the improved granite in Brooklyn as compared with the old is as follows:

	*No. Yards Maintained	New Method	Old Method
1914.....	266,664	Total, $43.95	$0.011 per yd.
1915.....	417,502	0.004 per yd.	0.024 per yd.
1916.....	536,067	0.007 per yd.	0.03 per yd.

*Figures only refer to yardage of improved pavement.

It must be understood, however, that the old method streets were first paved in 1895, while the first improved pavement was laid in 1910. So that there was 15 years' difference in the age of the pavements.

Extracts from Specifications for Granite Block Pavement on Bedford Ave., Brooklyn

On the subgrade thus prepared shall be laid the concrete foundation 6 ins. thick, consisting of 1 part of Portland cement, 3 parts of sand and 5 parts of broken stone or gravel.

The granite paving blocks shall be of fine grained granite showing an even distribution of constituent minerals, of uniform quality and texture, without seams, scales or disintegration, free from an excess of mica or feldspar and equal in every respect to the samples in the office of the chief engineer. The granite shall have a toughness of not less than 9 and a French co-efficient of wear of not less than 11, as determined by method employed at the United States Department of Agriculture, Office of Public Roads.

Blocks shall be of the following dimensions, viz.: Not less than 7 nor more than 11 ins. long on top, not less than 3¾ nor more than 4¼ ins. wide on top, not less than 3¾ nor more than 4¼ ins. deep.

The blocks shall be cut so that the faces will be rectangular in shape and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ⅜ in. in width at the top and for 1 in. downward therefrom and not exceeding ¾ in. in width at any other part of the joint. The top surface of the block shall be cut so that there will be no depressions measuring more than ¼ in. from a straight edge laid in any direction on the top and parallel to the general surface thereof. The blocks will be measured and all blocks not conforming exactly with this specification will be rejected.

On the concrete foundation hereinbefore described shall be laid a bed of clean, coarse, dry sand mixed with cement and averaging ¾ in. in depth so as to bring the surface of the pavement, when thoroughly rammed, to the proper grade. The sand shall all pass a ¼-in. mesh screen and shall be thoroughly mixed with the cement in the proportion of 1 part of cement to 4 parts of sand. Upon this bed the blocks shall be laid at right angles to the line of the street, and in a straight line from curb to curb, except in special cases when they shall be laid at such an angle as may be directed by the engineer, who is also to determine the grade and crown to which the blocks must conform. Each course shall be of uniform width, and so laid that all longitudinal joints shall be broken by a lap of at least 3 ins. The stone blocks shall not be laid more than 25 ft. in advance of the ramming. No blocks or other material must be thrown or deposited in such a manner as to displace the blocks on the face of the work, and no carting will be permitted over the surface of any unfinished portion of the pavement.

Immediately after the blocks are laid they shall be thoroughly rammed and brought to an even and true surface.

After the pavement has been brought to a uniform surface it shall be sprinkled with clean water and Portland cement grout shall be poured into the joints until it appears on the surface. The grout shall be broomed into the joints if necessary to fill the same, and the operation shall be continued as the grout settles, until the joints are thoroughly filled flush with the surface of the blocks.

The cement grout shall be composed of 1 part of Portland cement and 1 part of clean, sharp sand passing an 8-mesh per inch screen. The cement and sand shall be thoroughly mixed dry and sufficient clean, fresh water shall be added to give the grout proper consistency.

The grout shall be mixed in a machine mixer, approved by the engineer. The character of the mixer shall be such that the mixing of the grout shall be continued until the instant that it is poured into the joints.

The work of filling shall be carried forward until an advance area of 15 or 20 yds. has been grouted, when the same force and appliances shall be used to regrout the same space in a like manner.

The work shall be kept lightly sprinkled with water ahead of the sweepers, to avoid a possibility of causing the grouting to become too thick at any point. To insure the penetration of the grout into the joints of the pavement a squeegee scraper 15 to 18 ins. in length in addition to the broom shall be used upon the last application of the grout.

After the grout between the joints has fully subsided and

the initial set is taking place, the whole surface shall be lightly sprinkled with water and the surplus grout left on the top shall be swept off. After the grouting is completed and a sufficient time for hardening has elapsed, so that a coating of sand will not absorb moisture from the cement mixture, ½ in. of sand shall be spread over the whole surface.

After the grouting is completed the street shall be kept closed and no carting or traffic allowed on any part of the grouted pavement until at least 10 days have elapsed. The surface of the pavement shall be kept moist, as may be directed by the engineer.

Recut Granite Blocks

The most radical change in granite pavement construction during the last few years has been the use of recut blocks. The old large blocks that were previously discarded entirely when a new pavement was laid have in many instances been recut into blocks of different dimensions and used to good effect. The very large size of the old blocks has made this possible. In some cases it is stated that the recut blocks

RECUT GRANITE BLOCKS LAID ACROSS CENTRAL PARK, NEW YORK CITY, READY FOR JOINT GROUTING.

laid a larger area of pavement than the old ones. As has been stated heretofore many pavements have been replaced not because the old blocks had been worn out, but worn in such a way as to be too rough to be serviceable. A block, for instance, originally 4x8x12 ins. that had become somewhat turtlebacked under traffic could be cut perpendicularly to its original surface so as to make three good blocks 4 ins. deep each with a wearing surface of 32 sq. ins. or 96 sq. ins. in all, while it originally had a surface of 48 sq. ins. only. These blocks, of course, would not be recommended for heavy traffic streets, but in certain cases where for grade or other reasons a stone pavement was desired, if laid in a mortar bed with a cement grout filler, they would give entire satisfaction. Strangely enough, the idea of recutting blocks was first presented to the writer by a producer of granite blocks himself, one who would naturally be interested in selling new blocks, but he really wished to see the old material used to its full advantage. As this proposal was made some years before any work of this kind was done it seems altogether likely that he was its originator.

The New Central Park Pavement

A pavement of this character was recently laid on the roads running across Central Park, New York City. The old blocks were taken from Third avenue, which was being repaved, and were originally 3½ to 4½ ins. wide, 7 to 8 ins. deep and from 9 to 12 ins. long. The specifications required the new blocks to be 3½ to 4½ ins. wide, 4¾ to 5½ ins. deep and 6 to 10 ins. long. This did not allow as radical a saving as the example previously given on account of the size of the recut block. The old blocks had been in use 24 years and with the old practice would have been thrown away or used for some minor purpose. The recut blocks were laid with a mortar bed and a cement grout joint. The pavement cost $2.15 per sq. yd., a saving of $2 or more per yard.

If the old blocks can be cut and used on the same street the maximum amount of saving will be had.

Construction Plant and Methods Employed in Building Reinforced Concrete Roads at Camp Custer, Battle Creek, Mich.

By George A. Burley, of R. D. Baker Co., Penobscot Bldg., Detroit, Mich.

I do not believe that permanent pavements were embodied in the original plans for Camp Custer, the National Army cantonment near Battle Creek, Mich., inasmuch as no contract was let for their construction until long after the building, sewer and water works contractors had been on the ground. However, from the nature of the soil, which is very sandy, it soon became evident to the engineers that gravel or macadam roads would not stand up under the heavy army truck and mule team traffic necessary to carry supplies to the various parts of the camp. They then decided on concrete for the main roads and gravel roads between the barracks.

On the 19th of July, 1917, we arrived on the grounds without any equipment, as the siding from the M. C. R. R. was not yet halfway up to the camp and the roads were bad for drawing in any heavy machinery. The following day we had about 20 teams with Western wheel and slip scrapers at work grading and a large number of men cutting and grubbing out about 1¼ acres of trees at the eastern end of the camp. We had no grade stakes to begin with, only a general line being given, and had we known that such large cuts and fills would be encountered we would have shipped in a steam shovel as it would have greatly facilitated the work. The first fill made was about 13 ft. deep and so steep were the sides of the hill that it was necessary to drag the wheel scrapers down without raising them in order to avoid running onto the teams.

All stumps that were not covered by at least 2 ft. of earth were grubbed out and those that were left in, regardless of the depth of fill, were cut off flush with the ground. The trees were trimmed up, the brush burned and the timber hauled into piles to be used for various construction purposes about the camp.

The specifications called for rolling all fills in 9-in. layers with a 10-ton roller. It was, however, found impossible to get a 10-ton roller down into the bottom of the fills and to operate it successfully in the red sand. It continually stalled and required jacking out. We then abandoned rolling with a 10-ton roller and obtained two 1½-ton Beach corrugated rollers, which gave the best of satisfaction, and I am of the opinion that in rolling soft material they are superior to a heavy machine. The first time over they go down quite deeply and seem to pack the fill from the bottom up. When the fill was brought to grade and all rolled with 10-ton rollers of the Buffalo-Pitts type, we found that the fill held the rollers up better than the original ground in the cut. These rollers required two teams each for their operation if employed continously. All sods were removed unless covered by a fill of at least 2 ft.

About ½ mile of rough grading was completed before the railroad siding was in and then we unloaded a Thew 1-yd. clamshell for unloading material from the cars, a No. 11 Koehring mixer, 1½ cu. yd. industrial cars and track for delivering material to the grade. As the soil was so light, we anticipated trouble in keeping up the track if a locomotive was used and so did not ship one in, but handled the cars with teams. As

the first part of the work was up hill and down, we kept teams at the foot of the hills to haul the trains of 4 to 6 cars up and men operating the brakes would ride them down. With this method of handling material we could put from 8 to 10 carloads on the grade per day. Where possible we laid a double line of track and dumped in toward the center. The double tracks permitted operating without switches.

Our greatest difficulty was in the congestion at the sidings. Cars were continually running over the industrial track and the heavy trucks and teams hauling lumber would knock the tracks out of line and sometimes stall so as to tie up the cars or derail them. Yet, we believe, this was the most ecenomical way of handling the material, as the grade would have been cut up badly if we had undertaken to haul the material in wagons. Trucks would have been out of the question as in hauling lumber and other supplies for the buildings it was necessary to put brush, hay and even ensilage on the roads to get those trucks through the sand. Even with this method it was almost impossible to maintain a finished grade ready for the concrete for any distance ahead of the mixer. We finally resorted to fencing to keep traffic off the grade and a force of men was continually employed driving 2x4-in. stakes with a single 2x4-in. rail on top. Besides this cross fences were put up, for should drivers break through with trucks they would run straight down the finished grade.

Material used for the concrete was washed sand and gravel from Kalamazoo. This material was fairly clean, with the exception of times when it rained, when the top soil was not stripped off, the clay would wash down into the gravel to a greater extent than the washing plant could remove it. A number of cars of gravel were rejected for concrete and were used for shoulders. No check on this material coming in was kept, as we took the total output of the pit and then occasionally were held up through lack of sand and gravel. The cement was purchased from three nearby cement plants, Peerless, Wolverine and Burt, and the delivery was very good, but trouble was experienced because other contractors unloaded our cars, and at times we were completely out of cement due to this confusion.

The mixture of the concrete was about 1 of cement, 1½ sand and 3 parts gravel. I say "about" because the sand not being graded from fine to ¼ in., a shovelful of cement was put into the hopper from a wheelbarrow. After the concrete was finished small depressions would occur in places between the coarser aggregates, due to the settlement of the neat cement, also small pores would appear. The engineer's attention was called to this and he ordered additional cement added to make up for the lack of grading in the sand. This was an aid, no doubt, but as neat cement is not as hard as particles of sand it did not produce a wearing surface capable of resisting wear as well as a graded sand.

Baker steel side forms were used except on very short curves, where they were replaced by 2x6-in. plank, which could be bent to the required radius. To insure against settlement of the forms, they were set on 2x2-in. hubs driven with their tops 6 ins. below grade.

The main road, which was 18 ft. wide, 6 ins. deep at the edge and 8 ins. at the center, was reinforced with American Steel and Wire mesh and Kahn reinforcement. The reinforcement was cut in 14-ft. strips and placed staggered in the concrete. The first strip of reinforcement was laid 1 ft. from the edge and extended to within 3 ft. of the other edge. The next strip was placed 3 ft. from the corresponding edge and extended 1 ft. from the other and so on. This I believe to be the best method of reinforcing as it uses a minimum of steel and at the same time places the heaviest reinforcement where it is needed at the center. Joints were placed every 30 ft. using a ½-in. Elastite filler and the reinforcement extended clear to the joint. The filler was 9 ins. wide and the joint was finished with a split float. After the concrete was set the felt was cut off flush with the surface. As we had no finishing machine ready to place on this work, the surface was finished by passing two belts over it, a narrow and a wide one, and the edge of the concrete was slightly rounded along the form.

During the hot weather the concrete was covered with about 2 ins. of earth and kept watered for seven days. The cover was left on until time to open up the road. Great difficulty was experienced in keeping traffic off until the concrete was properly cured. Six carpenters with helpers were continually putting up barricades and fences and yet teams or trucks would occasionally cross it. In some cases so great was the demand for its use that the road was opened up sooner than we desired. Often crossings were put over the green concrete the next morning after laying to allow for hauling material from various sidings. These were made by spreading on a thin layer of earth and then covering with a double course of 2-in. plank. No bad results were noted from such crossings over the green concrete.

For the greater part of the construction the water was obtained from creeks and lakes and pumped through a 2-in. pipe line with New Way gasoline engine driven Fairbanks-Morse pumps. So great was the distance and elevation to be pumped from one lake that where two mixers were used it was necessary to put a booster station in the line. This was so arranged that should the first pump fail to deliver sufficient water it would pump into a tank halfway and the second pump would take it from there and force it on. Most of the pipe line had to be covered by plowing a furrow and dropping it in, as motor trucks and teams were continually crossing in every direction. We were also troubled by the trenching machines that were putting in sewers cutting through our water pipe. It required us to have continually in readiness a team carrying fittings, tools, pipe vise, etc., with two men to keep the pipe line in repair.

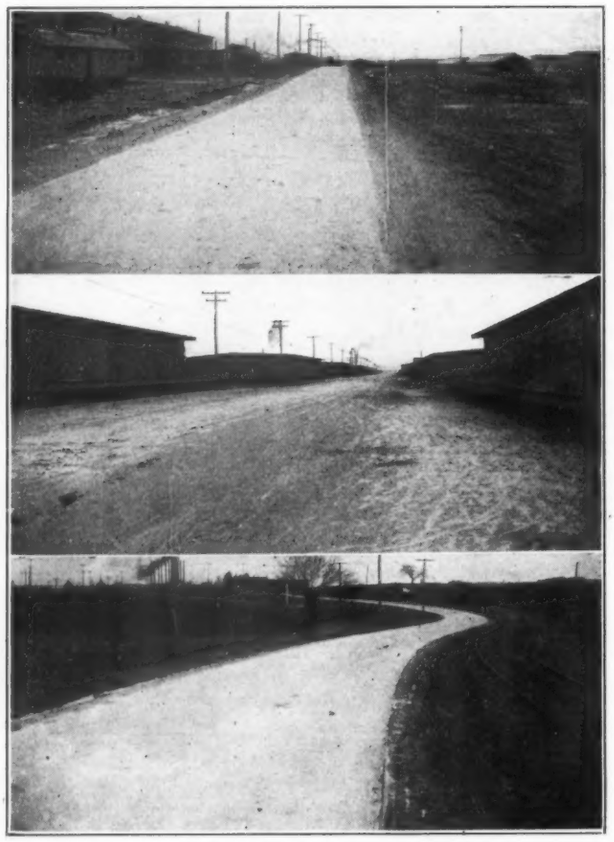
As the work first anticipated did not greatly exceed 3 miles, only one mixer was placed on the job, but after it was decided by the government engineer to double this amount we hurried another No. 11 Koehring mixer to the camp and put it to work. Twelve turns of the mixer was specified for each batch, yet we were able to put in as high as 360 lineal ft. per day of 18-ft. road, and with one mixer we placed 9,000 ft. in 30 days.

The warehouse section was the most difficult to construct as we had to arrange our work so as to make it possible for army trucks to obtain supplies. This necessitated our shifting up and down between the warehouses, putting in pieces here and there. The warehouse pavement was about 1,600 ft. long and about 60 ft. wide between buildings and 6 ins. thick, all of which was reinforced. This pavement was placed on a fill of 2 to 3 ft., and was flat with a slope in one direction.

The difficulty was not in obtaining labor for this work, but to get work out of the labor. All classes of labor were employed, even to Mexicans, and during the early part of the work nearly 50% of the entire force either quit or was discharged each week. This necessitated our employing a man to obtain labor and it was his duty to bring a truck load out to the camp each morning. The labor was paid 35, 37½ and 40 cts. per hour for 8 hours and time and one-half for overtime, making 11 hrs. pay for 10 hrs. work. The variation in the price depended on the class of work done. The crews at the mixers were almost entirely negroes and proved the most satisfactory class of labor we had. The employes were housed in tents, farmhouses that were abandoned by their owners, and even garages and granaries were fitted up with army cots and blankets to take care of them. In the early part of the work they were kept in government barracks, but when the drafted men began to arrive, being continually moved from one building to another, the laborers became dissatisfied and so we ar-

ranged to take care of them in other places. All workmen were fed at the commissary, if they desired, by purchasing tickets at 35 cts. per meal or 3 meals for $1. These were charged to their account and a constant check had to be kept on this as the men gambled in meal tickets and many would overdraw their account if possible.

There were employed as high as 92 teams on this work, grading, hauling cement and material for the concrete road and hauling gravel from a local pit for the gravel roads. These were all taken care of in four barns, two of which were government built and the other two remodeled barns vacated by farmers forced to move from the reservation. Each barn was in charge of a "barn boss," whose duty it was to see that



VIEWS OF REINFORCED CONCRETE ROAD BUILT AT CAMP CUSTER, BATTLE CREEK, MICH.

Upper: Main Road Back of Barracks, Practically Only Level Stretch. Middle: Between Barracks Buildings, 60 Ft. Wide on 2 to 3 Ft. Fill. Fill on Curve; Only Place Where Unloading Track was Near Road.

all teams in his barn were properly cared for and that all went to work on time supplied with the equipment necessary for that job. They also reported any teams "standing in" through lack of teamsters so that our employment man could supply new ones each morning or pick out some teamsters from among the laborers. It was also their duty to advise the office as to their requirements for hay and grain. Baled hay and oats in bags were purchased in carloads. By order of the sanitary department all litter had to be removed from the barns each day and, as this had to be hauled about 3 miles, one team was detailed from each barn for this work. To take care of horseshoeing and general repairing a fully equipped blacksmith shop was built and two blacksmiths employed. Teams were paid at the government schedule of 30 cts. per hour, time and one-half for overtime and 10 cts. per hour being taken out for feeding. This made a charge of $1.10 per day for feed, which we found at the price of hay and grain barely covered the cost. All teamsters were hired by us and received 35 cts. per hour. Where dump wagons were used the team owner received 50 cts. per day rental. The greatest number of men employed on this work was about 280. This large force was required in order to carry on the gravel road construction along with the concrete.

All laborers were given brass number checks and one timekeeper covered the whole job. In the first part of the work the men checked in at stiles morning and afternoon and out at noon and night. The timekeeper also checked them on the job in the forenoon and afternoon. The checking of numbers at the stiles consumed too much time and was of little value because of the large number employed, so was abandoned later when each foreman was given a time book and checked the men in and out, turning the book over to the time keeper. The week ended on Saturday night and pay day was Wednesday. Payment was made by check, which made considerable office work.

Ditches were built on each side of the road to drain to the natural water courses with cross culverts of Armco corrugated pipe placed at close intervals for cross drainage. Adequate disposal of storm water was not provided in many cases because camp buildings were built without regard to natural water courses. The shoulders were carried out with 6 ins. of gravel 2 ft. from the concrete on each side and throughly rolled, and the roadway made 24 ft. over all. This gravel was obtained from a local pit and clammed into Studebaker dump wagons.

"Sacrifice economy for speed," was the order from the constructing quartermaster. Yet this did not in any way overcome the difficulties in connection with the work. In order to facilitate the construction of the hospital itself we placed a large grading force on the railroad with the understanding that the railroad was to be torn out and the heavy grade used for pavement. With only 3 days' notice we were told that the railroad would remain and we must grade through to the hospital alongside the railroad. Conditions like this made it difficult to plan the work ahead in order to keep two mixers going continually, but we did this from the time we started until the job was finished.

The railway sidings were very badly congested with building material, tile, water works pipe, etc., and although the mixer was working within a few hundred feet of a siding it was sometimes necessary to haul the cement a mile. Switching service was very unsatisfactory. Often the unloading gangs were laid off with material in the city yards that could not be brought to the camp in time.

Considering the difficulties encountered we believe good time was made, as from the 20th of July until we began loading equipment on the 29th of November, 60,360 yds. of concrete were placed and about 8 miles of gravel road built and 3,000 ft. of 12-in. crock laid. Five hundred feet of this concrete was laid on an old road bed and the balance all passed through woods and farming country, with big cuts and fills and many curves. At one point the concrete is laid over a fill of 30 ft., which was made with a steam shovel and cars. It will be interesting to note what settlement takes place at this point. The actual mixing time in placing this concrete, which is equivalent to building approximately 6 miles of 18-ft. road, was 3 months and 10 days.

No accurate costs on the road work can be given. This is due to the extra work done, such as railroad grading and digging the basement for the laundry, for which no separate cost account was desired by the government. And as this work took in so many conditions that are not met with in the ordinary road building we did not consider a cost record of any value to us.

Destruction of Wood Block Pavement Due to Use of Tar in the Creosote Oil

By P. C. Reilly, Republic Creosoting Co., Indianapolis, Ind.

The serious results that follow the use of wood paving blocks, which have been treated with creosote oil mixed with tar, are well known to almost every paving engineer, chemist and contractor. The history of the pavement laid in 1909 on Washington Boulevard, Indianapolis, can be duplicated in many parts of the country.

Extreme Bleeding

The blocks were treated with 20 lbs. of a tar-and-oil mixture to the cubic foot. For the first three years the street was not usable during the summer months, as the tar exuded from the blocks in such volume as literally to flood the street. Automobiles were forced to detour and the property owners were obliged to lay planks at the crossings to avoid spoiling their shoes, carpets and floors with tar.

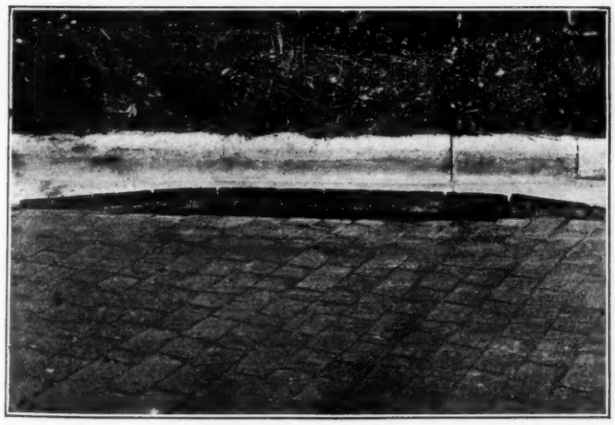
The street was not usable because of this bleeding during the summers of 1910, 1911 and 1912. For the three years following this bleeding period it was seemingly in fairly good condition, bleeding and buckling somewhat, but neither to a harmful degree.

Tar Bled Out, Leaving Fibers Exposed

From the events which followed it seems safe to assume that practically all of the tar had reached the surface and either exuded or formed a surface coating, which was gradually being worn off by traffic, for by the end of the second three years the surface coating of tar had lost its efficacy, the elements had removed the volatile portions of the creosote oil, which are always present in such mixtures, and the wood fibers were left without protection.

As a result, beginning with the fall of 1917, bulging from the entrance of water became so bad that the pavement has become very dangerous to traffic, as shown in the accompanying photographs.

Chronologically, therefore, the history of the pavement is this: For the first three years it was not usable and a nuisance because of the bleeding of the tar from the blocks.



VIEW SHOWING EXPANSION AT CURB LINE OF TAR-AND-OIL TREATED WOOD BLOCK PAVEMENT ON MERIDIAN STREET, INDIANAPOLIS.

For the next three years the street was usable, but showing signs of rapid deterioration, at a time when a properly treated block pavement would hardly show signs of service.

Bulging

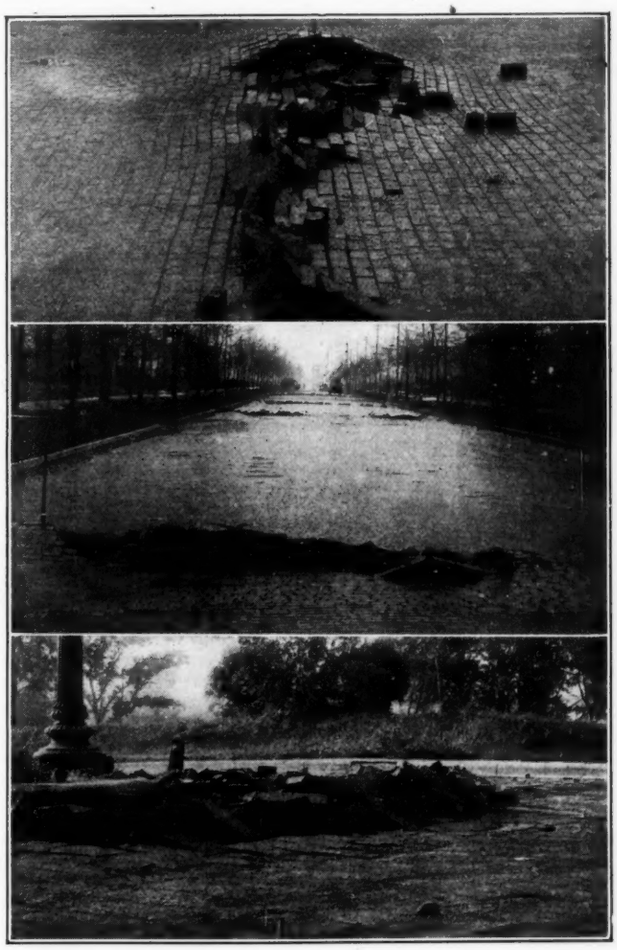
The bulging period then set in, and it will be a constant source of danger and expense on this street, for it cannot be remedied and will continue to grow worse. It may be retarded temporarily by coating the surface with pitch or some similar surfacing material, but the relief will be temporary, at best, because the pitch cannot penetrate to the interior of the blocks, and the water will enter through every break in the surface.

This tar-and-oil mixture has been widely used in past years, and almost always with results similar to those here set forth. It is not a creosote oil in any sense; it does not make a creosoted paving block, and pavements of such blocks should not be confused with the genuine creosoted wood block pavements, which are entirely free from such troubles if properly treated.

Defects of Tar-and-Oil Treated Wood Pavements

The reason for the wholesale failure of tar-and-oil treated wood block pavements, and for their rapid decline in popular favor, is immediately apparent to engineers and chemists, for it is impossible to secure permanency from a mixture which contains both volatile elements and substances which are constantly changing in their chemical composition. Such materials are not stable and stable results cannot be obtained from their use.

Engineers and chemists know, too, that if materials incorporated in a pavement subsequently exude or evaporate from



VIEWS SHOWING BULGING OF TAR-AND-OIL TREATED BLOCK PAVEMENTS, INDIANAPOLIS, IND.

Upper—Washington Boulevard Pavement, February 12, 1918. Laid in 1909. Between Thirty-fourth and Thirty-sixth Streets. Middle—Another View of Same Pavement. Lower—Expansion in Pavement Shown Occurred in One Day. Pavement Fifteen Years Old.

that pavement, there will be left voids in the pavement which will quickly be occupied by water, air and other agencies of destruction. This is exactly what happens where pavements are treated with any tar-and-oil mixture.

It is well known that a creosote oil of the proper quality will produce a stable pavement—one that is permanently resistant to the effects of moisture and which therefore will not

bulge. Nor can it bleed tar, as there is no tar in its composition.

Such an oil should be absolutely pure; it should have a specific gravity of not less than 1.12 at 25 deg. C., and it should respond to the well-known tests for determining quality and purity.

An oil of this kind penetrates the most minute cells of the block and becomes fixed therein—a constant barrier to the entrance of harmful agencies which attack unprotected blocks. To insure securing such an oil, specifications should be most carefully drawn, with great attention to detail.

It is unfortunate, in one sense, that this Washington Boulevard pavement gave fairly good service during the intermediate period, for during this period it might have been considered a good representative pavement. Its inherent defects were not visible to the casual observer, while if the pavement had been continuously bad from the beginning it would not have been nearly so harmful to the prestige of the true creosoted wood block pavement.

Chemists and engineers are expected to guard the interests of their communities against obvious mistakes, and it is a mistake to use a creosote oil which has been adulterated with tar or which contains volatile elements that are subject to evaporation or dissolving when exposed to the elements.

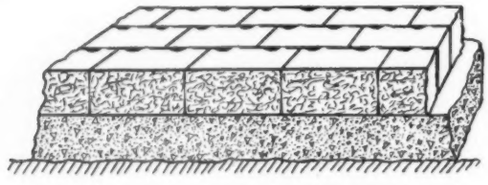
Some Design and Constructional Features of Modern Brick Pavements

By F. A. Churchill, Conneaut, Ohio

Modern brick pavements are of two general types: monolithic and composite. A monolithic brick pavement, as the name signifies, consists of a single rigid beam. Depth of beam is beside the point. The monolith may be a single course of grouted brick laid on natural soil, or it may comprise two or three strata of different materials united in a solid beam unit.

Pavements Without Artificial Foundations

In many sections of the South, where frost action is negligible, and in several Northern cities as well, the monolithic beam is formed of a grouted brick surfacing only, the brick being laid on compacted natural soil. Where the soil compacts firmly and frost action is not troublesome, this type of construction can be relied upon to give satisfaction, with ordinary heavy traffic. Even in some Northern cities, in which the soil



WIRE-CUT LUG BRICK--GREEN CONCRETE FOUNDATION

CEMENT OR BITUMINOUS FILLER

is gravelly or sandy, pavements laid without artificial foundations have given acceptable service for many years. Cleveland, Ohio, has more than 30 miles of such pavement, and continues to lay some of it each year on natural soil foundation.

The Cement-Sand Bed

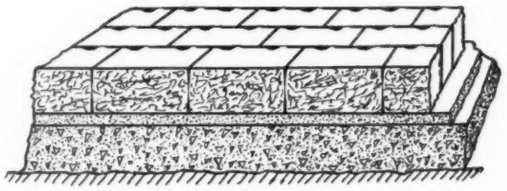
In many sections, especially in the Southern states, where frost upheavals are rare, the use of a 1-in. cement-sand bed under the brick, and the use of a 3½-in. brick, is becoming the prevailing type of construction. No longitudinal cracks appear in brick pavements in the South.

This type of construction has been used to some extent on state highways in Illinois, and on the Lincoln Highway in Indiana, and experience has demonstrated its value in resurfacing macadam roads with brick.

The 1 in. of cement-sand bed spread over compacted natural soil or macadam serves as a bedding course for the brick; it prevents the soil from working up into the joints when the brick are rolled, and, after it sets up, it protects the pavement against water which may invade the sub-grade. Unlike a sand cushion, the cement-sand bed does not shift or settle in spots.

Concrete Foundation

In sections where severe winters are the rule, or where heavy trucking, in the modern sense, may be expected, a monolithic pavement usually is constructed with a concrete foun-



WIRE-CUT LUG BRICK--CEMENT-SAND & CONCRETE FOUNDATION

CEMENT OR BITUMINOUS FILLER

dation either 4 or 6 ins. in depth. Generally speaking, a 4-in. brick is used for surfacing, but excellent results have been obtained with a 3½ or a 3-in. brick of a type affording exceptional bonding strength. Three-inch and even 2-in. concrete foundations have proven entirely satisfactory in some sections, notably in the South and in Illinois.

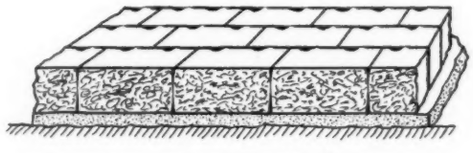
Local conditions of soil, climate and traffic should determine the depth of foundation specified.

Two Methods of Constructing Monolithic Brick Pavements

There are two methods of constructing monolithic brick pavements, although for convenience in distinguishing the methods, rather than as a means of differentiating types of pavement, these methods are often misleadingly referred to respectively as monolithic and semi-monolithic, or as green-concrete and cement-sand bed construction.

The two methods achieve practically the same result. With the first method the brick are laid on a green concrete foundation—if any foundation is used—either with or without a ⅛-in. film of cement-sand spread over the green concrete, in order to compensate the slight inequalities of surface which sometimes occur, unless extreme care is exercised in preparing the surface of the base.

With the second method a cement-sand mortar bed, usually in proportions of 1 to 4, thoroughly mixed in a mechanical mixer, is spread dry, not to exceed 1 in. in depth, over a cured



WIRE-CUT LUG BRICK--CEMENT-SAND FOUNDATION

CEMENT FILLER

concrete foundation, and the brick are laid on this bed and are grouted.

Theoretically, the cement-sand bed is converted into a mortar by wetting down the brick just before the grouting is done. The mortar bed effects a practicable union between the brick surfacing and the concrete foundation, and it assures an even bearing for the brick and a stable beam.

Either method necessitates shaping the surface of the concrete foundation as nearly as possible to a true contour and cross-section of the proposed surface of the finished pavement, and at the correct depth below the designed surface. In every case in which the cement-sand bed is used it is regarded as 1 in. of the foundation; that is to say, if a 4-in. foundation is designed, 1 in. of the 4 ins. is cement-sand bed. No cross-expansion joints are used on monolithic pavements, but on city streets where curbs are used, longitudinal expansion

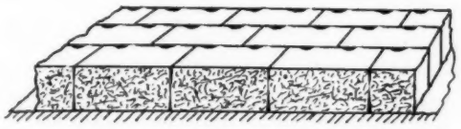
joints are placed alongside the curb to the depth of the foundation.

Green concrete construction was originally designed for highways especially, although it is adapted to streets as well. Cement-sand bed construction is more easily handled on wide streets, since a cured foundation is used; but it is fully as serviceable on highways and it is frequently so used.

Neither method requires flush side-edgings on highways. Earth or gravel shoulders give ample protection to the edges of the pavement.

Composite Pavements

Composite brick pavements are those in which unusual combinations of materials are used. Of these are brick pavements



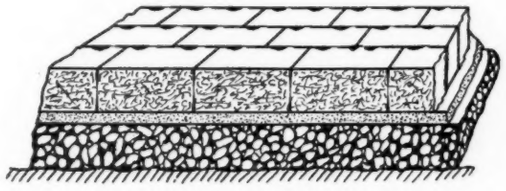
WIRE-CUT LUG BRICK--NATURAL SOIL FOUNDATION
CEMENT- FILLER

with bituminous filler and bituminous-bound foundation, or with bituminous-bound foundation, cement-sand bed and cement-grout filler.

A wire-cut lug brick pavement may be laid with the lugs down in green concrete and the rough, wire-cut side uppermost. Over this roughened surface a carpet of some bituminous preparation may be spread.

Vertical Fibre Method

This method of construction is known as the vertical fibre method, because traffic passes over what is theoretically assumed to be the ends of the structural strata of the brick instead of the strata running theoretically horizontal to the plane of traffic. Of course, no good paving brick has a pronounced stratified interior structure, and no brick has a fibrous formation. Shale or clay is ground fine, it is mixed thoroughly and the constituent particles are closely compacted, practically uniformly, by the augur machine and, in a good brick, they are vitrified in a virtually homogeneous mass of practically uniform density. The assumption, however, that good paving brick are noticeably stratified and that the brick set in one way present vertical stratification has given rise to the term



WIRE-CUT LUG BRICK--BITUMINOUS BOUND FOUNDATION
BITUMINOUS OR CEMENT FILLER

vertical fibre. As a matter of fact, the term vertical fibre applies to a method of construction rather than to any structural characteristic of the brick itself. If a paving brick shows any appearance of stratification it is due to laminations, which are recognized as imperfections.

Monolithic brick pavements possess several advantages over other types, whichever method of construction is employed. It has a greater strength per inch of depth, thereby rendering it feasible to reduce the depth of foundation without sacrificing required load-bearing strength or durability. It is practically noiseless; it averts weather hazards during construction; it eliminates side edgings; it obviates defects arising from material coming up into the joints and preventing the bonding material from penetrating to the bottom of the joints; it overcomes shifting or shrinking of the bedding course, and—a feature of the utmost importance just now—it economizes time in construction.

Speedy Construction

In these times of highway transportation of domestic commodities and war supplies, speedy construction of durable highways is of prime importance.

Where a green concrete base is used, brick pavements can be built rapidly if the contractor has adequate equipment and an efficient organization. All constructional processes go on simultaneously. That is to say, the preparing of the green concrete base and the laying, rolling, inspecting and grouting of the brick are all being done at the same time within a distance of 50 lineal ft., so that at the end of each working period the pavement is finished as far as any work at all has been done, excepting the preliminary grading and the placing of temporary side forms.

Output Per Day

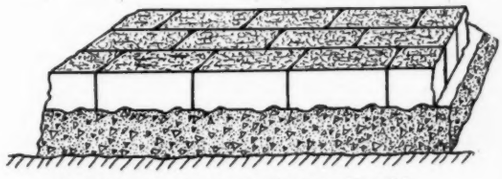
As no side edgings are required for highways, it is not uncommon for an organization of 25 men, aided by good mechanical equipment, to build 700 sq. yds. to 800 sq. yds. of monolithic brick pavement, with a 4-in. concrete base, in 10 hours. One contractor is reported to have built 1,000 sq. yds. of monolithic pavement in a working day, using mechanical conveyors for delivering the brick to the pavers; but the writer does not know the numerical strength of that contractor's organization.

The foregoing figures represent possible achievements rather than reasonable expectancy. Nevertheless, concentration of constructive energy within a small area, the elimination of periods of waiting for one portion of the work to set up before another step can be taken, the absence of weather hazards and the omitting of side edgings all combine to expedite construction.

When the sand cushion was used, a rainfall after the brick were laid, but before rolling, necessitated taking up the brick, re-preparing the sand cushion and relaying the brick; but rain does not damage green concrete foundations or cement-sand beds after the brick are laid.

Organization of Forces

Contractors are important factors in war-time construction in which the saving of time without detriment to good work is important. Contractors differ in their ideas of the number and distribution of men required in an organization. Local conditions often determine the arrangement. From 25 to 30 men is the rule for monolithic construction. In the smaller



WIRE-CUT LUG BRICK--VERTICAL FIBER TYPE
BITUMINOUS OR CEMENT FILLER
The Wire-Cut Lugs Embedded in the Concrete Foundation

organization each man should be highly efficient, there should be co-ordination of effort, and the mechanical equipment should be adequate.

Generally speaking, a contractor's organization large enough to construct from 500 sq. yds. to 700 sq. yds. of monolithic highway in a 10-hour day is made up as follows:

2 men—form setting.
8 men—concrete mixer.
1 man—finishing concrete surface.
2 men—dropping brick.
12 men—carrying brick.
2 men—culling and rolling.
4 men—grouting.

The number of men required for carrying brick can be re-

duced by the use of mechanical conveyors, if local circumstances justify their use. Sometimes the placement of brick conveniently allows retrenchment in the labor cost of handling. Each contractor organizes his force as he deems best, taking into account equipment, local conditions and the efficiency of the personnel, and depending somewhat upon his own organizing and executive abilities.

The men who lay the brick in the courses are factors in speedy construction. Brick should be handled quickly and placed properly without lost motion or waste energy. Twenty-five thousand or 30,000 brick a day is a good day's work for It is not unusual, however, for an experienced man to lay 30,000 brick in a working day.

Standard paving brick lay 40 to the sq. yd. Therefore, a man who lays 28,000 brick in a day surfaces 700 sq. yds., or approximately the yardage which a contractor's organization ought to construct, from base to grouting inclusive, in a 10-hour day on straight work, if the grading has been done and the forms have been put in place.

Standard brick of the wire-cut lug type weigh 9.3 lbs. each. A workman who lays 28,000 of these brick in 10 hours lifts—one brick at a time—and transports by hand a distance of at least 6 ins.—260,400 lbs. of vitrified brick, or 26,040 lbs. (13 tons) every hour. Obviously, ability to handle that amount of material properly involves a degree of natural aptitude, considerable expertness acquired by experience and steady application.

In monolithic construction, however, no portion of the work can be allowed to drag without impeding the progress of other portions or without prejudice to the pavement as a whole. The brick must be laid before the green concrete foundation takes its initial set and the grouting should be finished soon enough to assure a simultaneous setting up of foundation and cement-grout filler. This necessitates that the foundation unit keep out of the way of the bricklayers and that the rolling, inspecting and grouting units keep close up to the bricklaying. It is up to the contractor to perfect an organization in which all units co-ordinate.

Choosing Proper Grades for Various Types of Pavements

By Wm. Alden Brown, Assistant Engineer, City Engineer's Department, Providence, Rhode Island

The object of the present discussion is not to go into the relative merits of the numerous available types of pavement, but rather to consider their adaptability to various grades.

Durability, Cleanliness and Safety Depend on Grades

Any pavement to be at all satisfactory must, of necessity, be durable, clean and safe. Noiselessness is another important element as is also the question of repairs where broken into by the various public utilities. Now a pavement may be durable and safe on one grade but lacking in durability and entirely unsafe on another. The question of cleanliness, at least in a city, is not so much a matter of grades, when we use the term grades to mean the longitudinal rise of the street, as it is a matter of the contour or crown of the pavement, and the frequency of catch basins and inlets, closely supplemented by the work of the street cleaning department, said Mr. Brown in addressing the Municipal Engineering Section of the Providence Engineering Society.

Noiselessness is not much affected by grades. A given pavement will be noisy or noiseless according to traffic rather than grade, the number of horse drawn vehicles determining the relative noiselessness very largely. And the fifth requisite for a good pavement, that of repairs, is not a determining factor in selecting a pavement for a special grade.

Durability and safety then, if we exclude the matter of cost, are the two important factors in determining what pavement is best suited to a given grade.

Maximum Limits for Satisfactory Results With Grades

In the "Proceedings of the American Society of Civil Engineers," published in December, 1916, it is stated that "Conservative practice has fixed the maximum limits for satisfactory results with grades, as follows:

For gravel or broken stone	12%
For bituminous macadam	8%
For sheet asphalt	5%
For cement-concrete	8%
For brick (cement grout filler)	6%
For brick (bituminous filler)	12%
For stone block (cement grout filler)	9%
For stone block (bituminous filler)	15%
For wood block	4%

Waterbound Macadam

Considering these various pavements for a moment as they have hitherto been laid in Providence we find that we have waterbound macadam streets as steep as 13, 14 and 15% in several instances and in one case up to 16.5% in comparison with 12% recommended by the American Society and the fact of our having this type of pavement on these excessive grades constitutes a serious local problem.

Bituminous Macadam

Bituminous macadam, a type of pavement not suited to heavy traffic, but entirely satisfactory for light or medium traffic has been laid in Providence on a grade of 6.04% this being well within the 8% of the American Society and it would seem to the writer that 8% is rather steep for this pavement.

Tar Macadam

In Fall River, Mass., on Cherry St., tar macadam is laid on a 7% grade and, according to a statement of City Engineer Albert Wolstenholme, it has proved very slippery in winter. He adds, however, that too great a quantity of tar was used. He has found it necessary to have men with picks cut out parallel depressions about 6 ins. apart across the street so as to give a foothold to horses. Allowing, then, for a possible faulty construction, 6.5% insead of 8% would seem as steep a grade as should be paved with bituminous macadam.

Sheet Asphalt.

Sheet asphalt in our city has been laid on the approaches to the Union Station on grades over 4% and on Chalkstone Ave., being laid this year we have asphalt on a 7% grade on a partial width of the roadway in comparison with 5% as recommended by the American Society. In Syracuse, N. Y., the rule is that asphalt may be used for the whole width between curbs on grades up to 5% while on grades from 5% to 10% a strip of asphalt is laid in the center and on the outside granite blocks or brick are used.

Granite Blocks

Granite blocks with cement grout filler have in at least one instance been laid in Providence on a grade in excess of the 9% recommended by the American Society but on our steeper grades where this type of pavement is used, the joints are drawn as soon as the grout obtains its initial set.

Wood Blocks

The use of wood blocks in this city has for the most part been on grades of less than 2%, although on Brook Street, they are laid on a grade of 4.38% thus surpassing the 4% of the American Society very slightly.

Bituminous Concrete

The American Society recommends for bituminous concrete a maximum grade of 8% and we infer that the Warren Brothers "Bitulithic" pavement is included under this heading.

In Providence bitulithic has been laid on a grade of 5.19% which is a very conservative use of this pavement.

A writer on bitulithic says, "not only has the pavement proved a success on level surfaces and medium grades but

it has been found that by using a surface mix of a coarser layer than is customary on ordinary grades it will give a firm foothold for horses on grades as steep as 12%."

Steep Streets in Providence

My belief is that, on a grade steeper than 8%, while bitulithic might be relatively safe and suitable, a conservative judgment would decide that some other type of pavement would be better. A very serious problem in Providence is the final disposition of such streets of excessive grades as College, Waterman, Angell, and Thomas. These important streets are now built with plain macadam. It is felt that this pavement is unsatisfactory and in this decision we are in accord with the table of the American Society.

The objection to the macadam is lack of durability. A great change in paving has come about with the increase in use of the automobile and while under horse drawn traffic, the macadam on these streets proved moderately durable and entirely safe, it is now worn out with surprising rapidity.

In connection with the final disposition of these streets, it may be interesting, in addition to the recommendation of the American Society for similar grades, to refer to some of the correspondence of Mr. Bronsdon on this subject and also to a letter from Mr. Henry C. Allen, City Engineer of Syracuse, N. Y., to myself.

In a letter to Mr. Bronsdon from Mr. W. L. Weeden, Field Secretary of the Granite Paving Block Manufacturers' Association, in reference to College, Angell, Waterman, and Thomas Streets, he says, "In reference to a permanent paving, would say, that there is no question in my mind as to the advisability of paving these streets with such a material. In my personal opinion, granite will work out to the best advantage."

In a letter to Mr. Bronsdon from Mr. C. D. Pololck, consulting engineer, New York City, considering the paving of the steep Providence streets, the writer recommended "a narrow granite block as the paving material best suited to the grades and the traffic, and the joints should be filled with asphalt cement and sand, or with a mixture of asphalt, pitch, and sand. The cement, grout filler is suitable on lighter grades, but the bituminous filler will give much more satisfactory results on these grades."

An opportunity exists on Waterman Street, between Benefit and Prospect Streets, which has a grade of less than 10%, to adopt in part the recommendation, contained in the two letters quoted which do not conflict with the table of the American Society and in part a practice similar to that now in use in Syracuse, N. Y., and to which I have already referred.

On Waterman Street, which is 30 ft. between curbs, two strips 10 ft. wide of hillside brick with joints filled with bituminous filler and a strip of granite blocks in the center of the same width with joints also filled with bituminous filler would in the opinion of the writer be a very desirable change from the present macadam.

A more complete talk on grades must of necessity take into account the contour or crown suited to various pavements also modifications of the crown to meet the requirements on a flat or a steep grade and in addition a discussion of the various ways of grading intersections so as to dispose of the surface water, all of which topics I have omitted.

WATER WORKS DESIGN AND CONSTRUCTION

Design and Construction of the New Municipal Dam and Hydro-Electric Power Plant at Fort Dodge, Iowa

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Building, Kansas City, Mo.

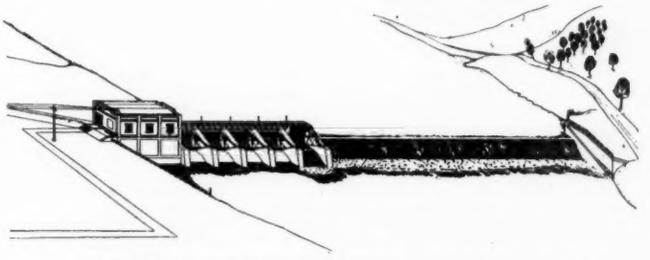
The city of Fort Dodge, Ia., with about 30,000 population and located on the Des Moines river, conceived the idea of building a municipal dam, with two objects in view: First, a financial investment that would be profitable to its citizens from the sale of power that would be developed; and second, the creation of a lake that could be utilized for pleasure purposes.

Fort Dodge being an inland city and a long distance from any body of water, the lake idea for fishing, boating and bathing proved to be very popular, but the citizens were determined that the project should be municipally owned and controlled. It was advocated by private parties with a franchise in view, but this was defeated at the polls, and after two unsuccessful efforts the city finally voted bonds for the municipal project. The feasibility of the project was patiently explained and exploited by Mayor John F. Ford for a number of years before the public became fully aroused as to its necessity.

Campaign for Bonds

The campaign for the bonds, under the auspices of the Commercial Club, was an interesting feature of the entire enterprise. The engineers transferred their preliminary plans, estimates and all data to stereopticon slides and these slides were shown at mass meetings previous to the bond election. The slides showed the proposed sites and also pictures of how the dam would look after construction, and with these illustrated lectures given by the engineers the citizens were enabled to vote intelligently on the project.

The bond issue for the improvements carried by a large majority, and on the 17th of June, 1916, contracts were let for the construction of the dam to the Koss Construction Company, of Des Moines, Ia., and for the power equipment and machinery installation to the Merkle Machinery Company, of Kansas City, Mo. The difficulty of carrying on the construc-



PRELIMINARY SKETCH MADE TO SHOW PROPOSED DAM, FOR USE IN CAMPAIGN FOR BONDS.

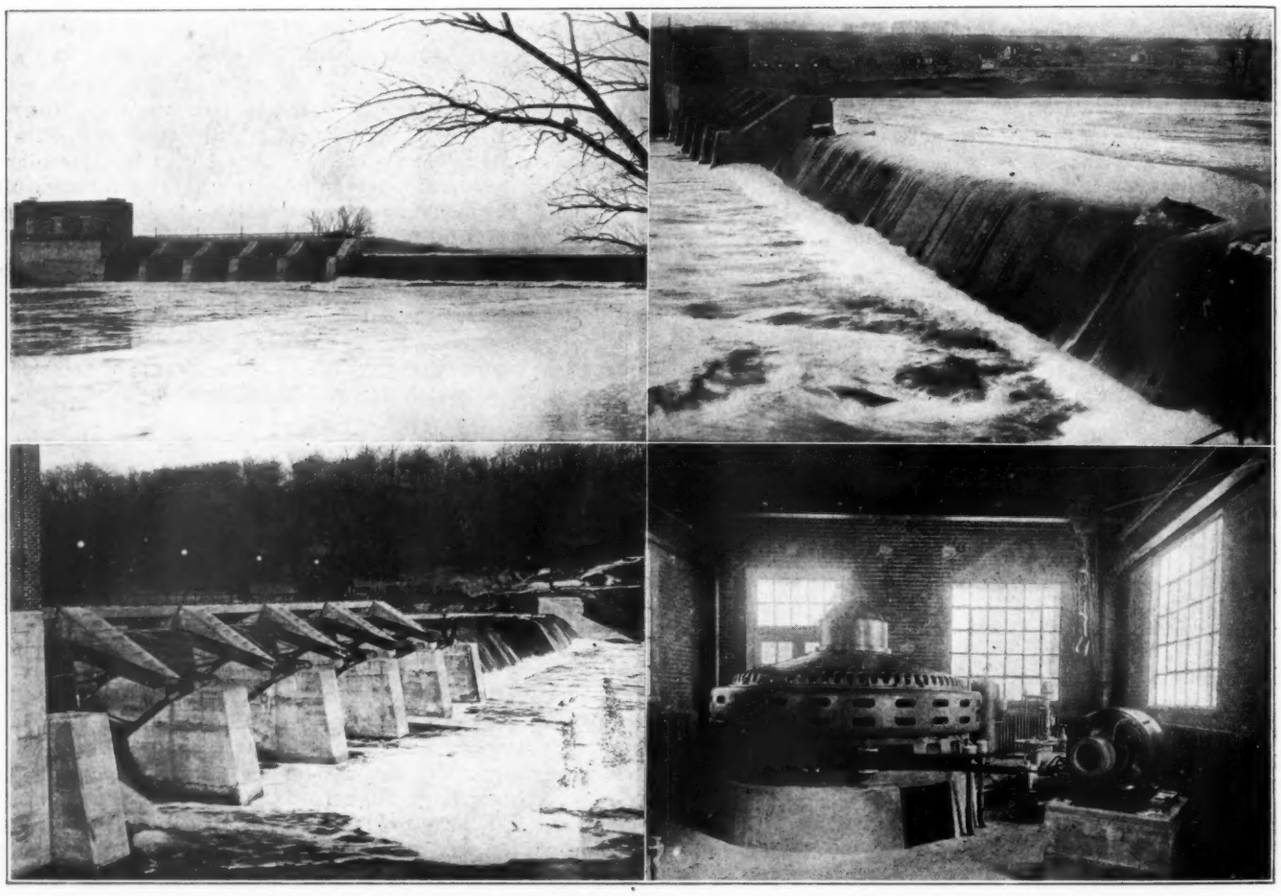
tion work through the scarcity of materials and labor, together with the handicap of high water and ice, made the whole project one of unusual difficulties in completion.

Design Features

The spillway section of the dam is 230 ft. long and is of solid concrete construction. One hundred and thirty feet of the dam consists of five sluice gates of the Tainter type, built of structural steel, with a radius of 17 ft., and arranged so that all five gates may be raised by a motor-propelled electric

hoist, allowing the flood stages of the river to pass through the gates, thus avoiding overflowing large areas of land that would otherwise be inundated at flood stages of the river. The dam has a height of 18 ft. above the bedrock of the stream, with a concrete toe 4 ft. deep and 3 ft. wide on the up-stream side. The concrete portion of the entire structure is 412 ft. wide, including a concrete fish-ladder at one end, as required by the state law of Iowa.

The raising and lowering of the gates controls the water level above the dam during high-water seasons, and they also control the water level above the dam in the winter and can be manipulated in order to avoid the structure being damaged by breaking ice in the spring.



VIEWS OF MUNICIPAL DAM AND HYDRO-ELECTRIC POWER PLANT AT FORT DODGE, IOWA.
Left to Right: Downstream View of Power House, Gates and Spillway—View Along Crest of Spillway—Close-up View of Tainter Gate Section—View of 500-h.p. Turbine.

Damage from Floating Ice

The concrete spillway of the dam was finished the 28th of February, 1917, and on March 21, three weeks afterwards, while the gates were open, a heavy mass of ice came down the river with so much velocity that it tore out the walls of the head-gate chamber and damaged the structure considerably. Before the gates could be closed large blocks of ice several feet thick passed over the dam, and the water on the down-stream side of the dam being low, the ice went over the dam without any cushion of water to break the force of the blocks of ice dropping over the dam. This grinding and hammering effect of the large blocks of ice on the toe of the dam caused a large hole to be scoured out on the down-stream side of the dam. The limestone was fissured, and through these fissures in the bedrock streams developed which scoured out a large opening under the dam.

Considerable damage was done before the gates could be closed and the water raised, so that the water then passed over the crest of the dam and the ice was given a cushion to fall upon as it passed over the structure, and prevented further damage.

Repairing Hole Under Dam

The repairing of the hole under the dam was accomplished by driving steel sheeting on the up-stream side of the dam and a cofferdam on the down-stream side of the dam, and the hole, which was about 60 ft. in length and high enough for a man to walk through, was poured full of concrete and a reinforced concrete apron was constructed on the down-stream side of the dam. The solid concrete dam for several months formed a perfect arch over the hole of the dam before repairs could be completed. The high-water stage of the river was passed before the repairs could be completed, thus adding another danger in carrying out the construction work. The entire repairs were finally finished on December 14, 1917, tested out and accepted by the city on March 1, 1918.

Cost of Project

The total cost of the project, including power house, turbine, generator and transmission line, was approximately $130,000. Careful examination showed the original structure of excellent construction, and the fact that the dam, for a stretch of 60 ft. from span to span over the opening, containing 3,500,000 lbs. of concrete, withstood the strain, seems to be ample evidence that there was nothing faulty about the concrete work.

Power Used to Pump City Water

The power house is of brick and reinforced concrete construction, 56 ft. long and 22½ ft. inside width. One 500-h.p. vertical turbine of the Francis type was installed and foundations are already built for a second unit, which will be in-

stalled later, giving a total development of 1,000-h.p. The power is transmitted to the water works station about three-quarters of a mile below the dam and used for pumping the water, and since placing the plant in operation the city has accomplished a saving of approximately $40 per day on fuel alone. Arrangements are being made for selling the surplus power, as there is a good demand for the power at a number of mills and factories close by.

The lake formed by the backing up of the water is about eight miles in length and will average 500 to 600 ft. in width. The wooded hills on each side of the stream and high bluffs at various points add to the attractiveness of the lake, and it is believed that the spot will prove especially attractive not only to the citizens of Fort Dodge, but to surrounding communities, who heretofore have been compelled to travel hundreds of miles to visit any recreation spot.

Personnel.

The design and supervision of the work was carried out by Burns & McDonnell, consulting engineers, of Kansas City, Mo., with Mr. Leland C. Angevine, resident engineer in charge of construction, who has since been retained by the city and placed in charge of the operation of the municipal power plant.

The entire municipal project is an excellent example of the accomplishing of both utility and attractiveness by procuring a power plant that is revenue producing, and at the same time providing a beautiful lake and pleasure resort that will be enjoyed by the entire community.

Cost of Machine Trenching Under Difficult Conditions for Water Mains and Services at Erie, Pa.

By Ed. W. Humphreys, Superintendent of Water Works, Erie, Pa.

When the General Electric Co. of Erie became heavily involved in government work, the housing question assumed gigantic proportions. Cost then became a matter of secondary consideration and urgent demands were made upon the city water department to rush to completion the installation of water mains and services.

Winter Work

It has been our rule to abandon all construction work during the winter months. This year, however, because of unusual conditions, the ruling was set aside and work was continued in spite of the severest weather of the past twenty years.

Soil in this operation consisted of a 3½-ft. layer of yellow, sticky clay, underlying which is a 4-in. layer of soft sandstone, which is immediately over some 3 or 4 ft. of hard blue shale. Frost had penetrated to the rock at all points of the operation and alternate thawing and freezing in the early part of the winter left a coating of almost solid ice to a depth of 3 or 4 ins.

The usual cleats used on this machine were V-shaped across the full 24-in. face of the wheel, and ordinarily would leave an imprint approximately an inch wide and 1½ ins. deep. It was, however, impossible to obtain any traction with these cleats, and even with the 19 tons tending to bear them into the ground, no impression was left on the mass of ice under the wheel.

Numerous experiments were tried to overcome this condi-

TABLE I—COST OF OPERATING TRENCHING MACHINE BY ERIE (PA.) WATER DEPARTMENT FROM MAY 1, 1917, TO JAN. 3, 1918 (EXCLUSIVE OF OVERHEAD, DEPRECIATION AND REPAIRS).

Operator—	Rankine Ave., N.	Rankine Ave., S.	22d, W. of Cranberry	28th, W. of Sigsbee	Cherry, N. of 30th	5th, W. of Raspberry	27th, W. of Cascade	Old French Rd.
Hours.....	62	26	4	3	2	3	2	1
Amount.....	20.15	9.10	1.40	1.05	.70	1.35	.90	.45
Labor—								
Hours.....	115	38	4	3	2	3	2	1
Amount.....	34.50	10.45	1.30	.83	.55	.98	.70	.35
Watch'n—								
Hours.....	50	101	29	63	29	89	15	14
Amount.....	13.75	20.20	5.80	12.60	5.80	22.25	3.00	2.80
Gasoline—								
Gallons.....	39	35	15	12	10	12	8	4
Amount.....	9.47	8.75	3.78	3.02	2.52	3.02	2.01	1.00
Oils—								
Quarts.....	4	4	3	4	3	1	1	1
Amount.....	.38	.46	.34	.46	.34	.10	.10	.19
Grease—								
Pounds.....	2	1	1	1	1	1	1	0
Amount.....	.15	.09	.09	.09	.05	.05	.05	.00
Total cost.	78.40	49.05	12.71	18.05	9.96	27.75	6.76	4.79
Lineal ft...	1,000	800	665	652	360	400	420	230
Cost per ft..	.078	.062	.019	.027	.028	.069	.016	.021

VIEWS OF P. & H. TRENCHING MACHINE IN SUCESSFUL OPERATION UNDER ADVERSE CONDITIONS BY ERIE (PA.) WATER DEPARTMENT.

Upper, Left to Right: Machine Digging Trench 24-in. Wide, 5½-ft. Deep, Through 44-in. of Frost and 22-in. of Shale—Machine in Operation and Sewer Trench Cut by Different Type of Machine—Another View in Same Locality. Lower Row: Extensive Housing Operation in Its Infancy—Machine Operating at Speed of 3½-ft. Per Minute and Cutting 26-in. of Shale—An Idea of the Soil Conditions and Difficulties to Overcome.

tion without success until we made cleats of 3-in. special angles, sharpening the cutting edge to facilitate its entrance in through the ice. A working speed of 1½ ft. per minute was the best rate we could attain.

Another obstacle in the way of successful and economical operation was the proximity of the sewer trench, which the photographs indicate.

In spite of all these things and with a crew consisting in all of nine men this 2,280 ft. of main was finally installed, and while the cost was under the conditions well within reason, we withhold mentioning the amount because it would involve a lengthy description and detailed explanation.

As an example of what the Pawling & Harnischfeger trenching machine accomplished on this work its performance on February 20, 1918, may be cited. On that day the machine dug a 2-ft. trench, 5½ ft. deep, through 44 ins. of frost and the remainder through a hard shale at the rate of 1½ lineal ft. per minute.

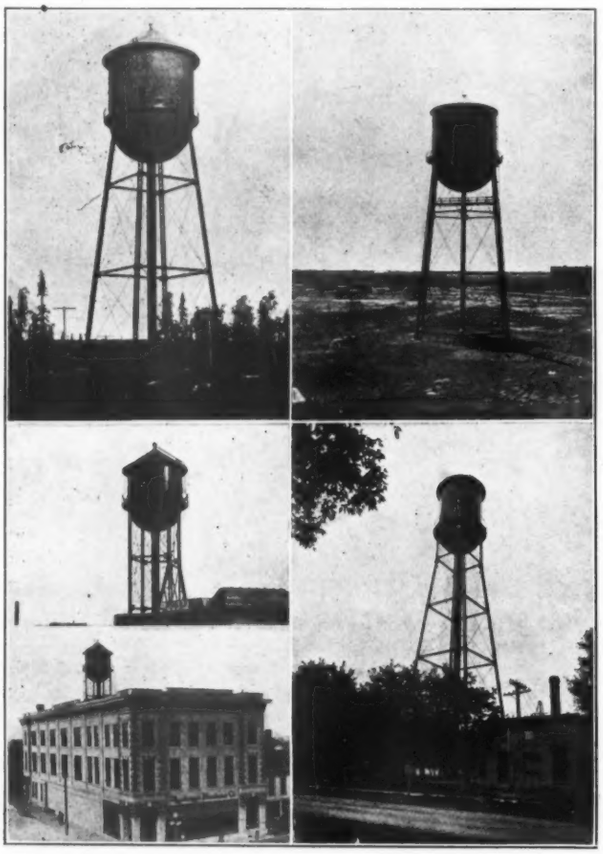
Performance Data on Trenching Machine from May 1, 1917, to Jan. 3, 1918

In Table I herewith are given data on the actual cost of operating this trenching machine from May 1, 1917, to Jan. 3, 1918, exclusive of overhead, depreciation and repairs. The table itemizes the actual operating costs on eight jobs of medium length.

Some Special Features in Recent Water Tank and Tower Construction

By Max Whitacre, Contracting Engineer, Pittsburgh-Des Moines Steel Co., First National Bank Bldg., Chicago

The four steel water tanks illustrated herewith, each possessing a special feature, have been erected recently by the Pittsburgh-Des Moines Steel Co. Following is a brief statement of the distinguishing characteristics of each installation:



RECENT WATER TANKS WITH NOVEL FEATURES. Left to Right: (Top) Anchorage, Alaska; Pearl Harbor, Hawaii; (Bottom) Alliance, Neb.; Albany, Minn.

Alliance, Neb.—This is a 20,000-gal. tank erected on a 30-ft. steel, hemispherical bottom tanks on an 80-ft. steel tower. This tank was erected on the corner of the building, making it necessary to support two columns on a truss as shown.

We have installed a large number of steel sprinkler tanks on buildings requiring special towers, and most up-to-date concerns are requiring their sprinkler tanks to be of steel.

Anchorage, Alaska—This is one of our standard 100,000-gal. steel, hemispherical bottom tanks on an 80-ft. steel tower, erected for the city of Anchorage, which is a terminal of the Government Railroad running back into the extensive Alaskan coal fields.

This is the first steel water tank to be erected in Alaska, and one interesting feature, which is not found on the usual tank, is the frost casing which completely covers the tank. On account of the severe weather experienced in Alaska this covering is required and it has proven satisfactory in every way.

Pearl Harbor, Hawaii—This is a 250,000-gal. steel, hemispherical bottom tank on a 110-ft. tower erected for the United States Navy Department at their hospital. This tank required no frost casing for riser pipe as the weather is not severe.

The special feature is the walkway which permits the inspection of the expansion joint. A valve was installed next to the tank bottom permitting the tank to be shut off in case repairs were to be made to tank riser or water mains.

The United States government requires steel tanks to be installed at all permanent stations or hospitals.

Albany, Minn.—This was a replacement job. We originally furnished and installed a wood tank for the town of Albany 18 years ago. The wood tank becoming unsafe on account of rot, we removed it together with the steel deck beams and by installing additional columns on the old tower were able to put on a new 50,000-gal. steel, hemispherical bottom tank.

The town now has a steel tower and tank 50x100, which is as good as a complete new structure as the old columns were in very good condition.

We have replaced about 150 wood tanks with steel, using about this same form of construction.

Construction Plant and Methods Employed in Building the Reinforced Concrete Reservoir at Highland Park, Mich.

By Paul Teas, East Ohio Gas Bldg., Cleveland, Ohio

Highland Park, Mich., adjoining Detroit and the seat of the Ford Motor Company's great industrial plant, has a population of about 20,000. The city plans to grow and in planning public improvements to meet future needs they are made large enough to take care of future growth. The handling of the enlarged water storage facilities is a case in point. The new reinforced concrete reservoir has a capacity of 45,000,000 gals and it is estimated that this will provide ample storage for years to come. The superceded reservoir now serves a coagulation basin. At the present rate of consumption the new reservoir will hold a four days' supply.

Design Features

The new reservoir measures 1,373 ft. long by 294 ft. wide by 14 ft. deep. It is supplied from an intake crib and pumping station on Lake St. Clair, eleven miles away, from which the water flows to the reservoir by gravity. Another set of pumps at the reservoir delivers the filtered water over Highland Park.

It is pleasing to note that the plans upon which this system was laid out, and the methods employed in building it, were in keeping with its importance—the Highland Park Reservoir enjoys the distinction of being one of the largest projects of its kind in the United States. Great credit belongs to Messrs. Lawrence Whitset, city engineer; Harry Hulbert, superintend-

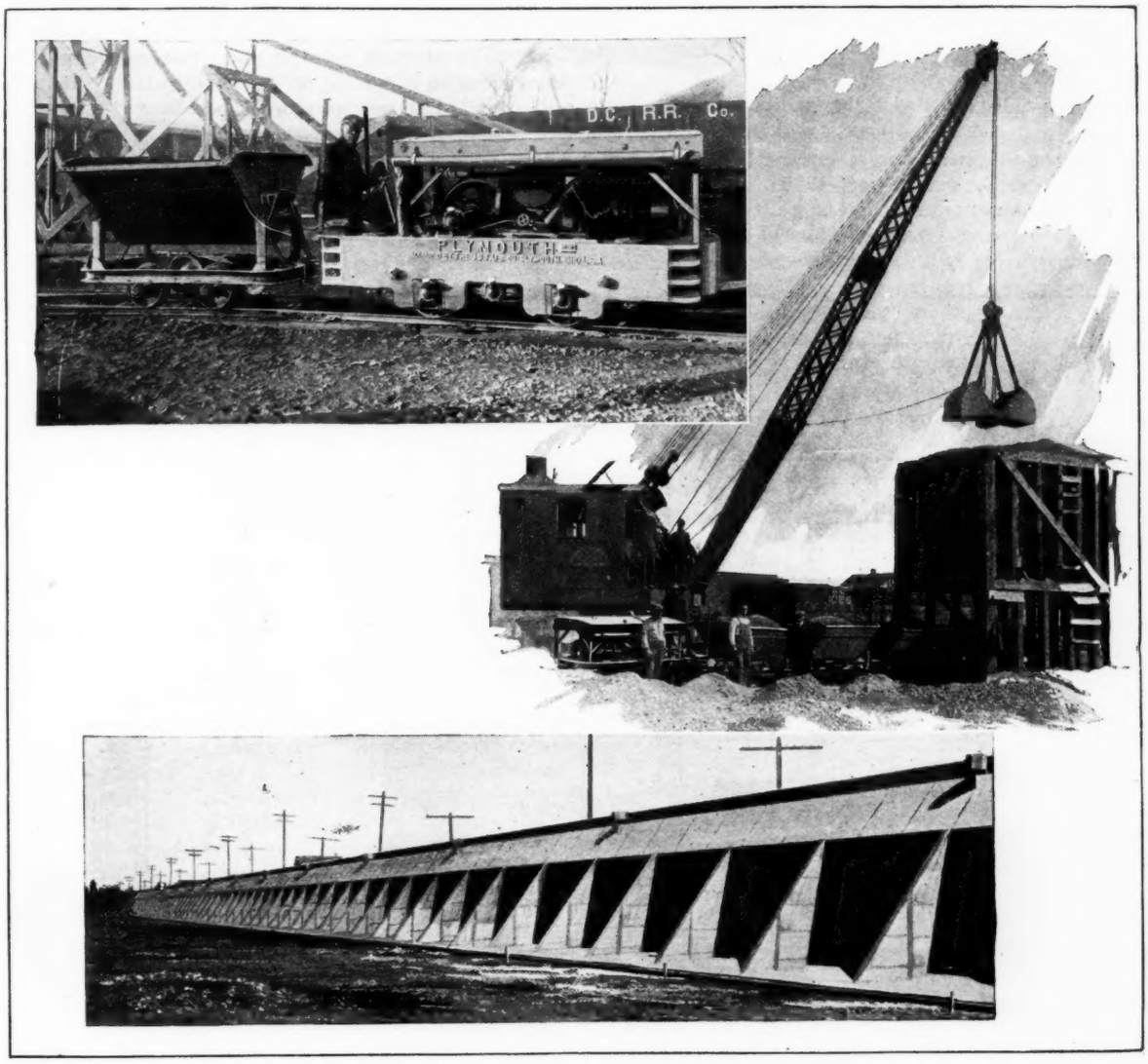
ent of public works; E. J. Lieber, engineer in charge of construction, and George L. Wright, concrete and steel foreman, for the thorough-going way in which the work was planned and carried out.

It was put through by the city on direct contract, and so thoroughly were all the details planned and so co-ordinated that approximately $15,000 was saved on a single section of the work.

cluded 22 industrial cars. In the storage yard were the main track and a number of spurs.

The material was unloaded from the gondolas by a locomotive crane and clamshell bucket, and stored in elevated bins —from which it was unloaded into the industrial cars by gravity and delivered to the mixers right on the reservoir floors.

A notable point about the pouring was the fact that the



CONSTRUCTION VIEWS OF WATER WORKS RESERVOIR AT HIGHLAND PARK, MICH.
Gasoline Locomotive Hauling Industrial Car—Locomotive Crane and Clamshell Bucket Unloading from Gondola Cars to Elevated Bins over Industrial Railway Track—Section of Finished Wall.

The design of the reservoir itself, the construction features entering into it and the facilities employed to keep things moving efficiently, are all in harmony with the importance of the work from the standpoint of immediate and future needs.

Construction Plant Employed

On every hand as one views this concrete structure is evidence of the builders' dependence upon machinery to do all the important work—accurately, thoroughly and in a big volume.

The excavating was done with three steam shovels—and that gives a key to the plan on which the whole job was put through. Inside the reservoir was a complete system of industrial railway, which kept the "front lines" supplied as the work advanced.

Two gasoline locomotives, of the type shown in the illustration, furnished the tractive power, and the equipment also in-

mixers were so spouted as to cover a 50-ft. strip of floor at each pass—25 ft. at either side. Very little hoeing was required to get the concrete in place and an average of 10,000 sq. ft. a day was easily maintained.

Liberal credit is given by the builders to the efficient transportation system, which permitted unloading the materials from the railroad at one point and rehandling it economically as the work advanced.

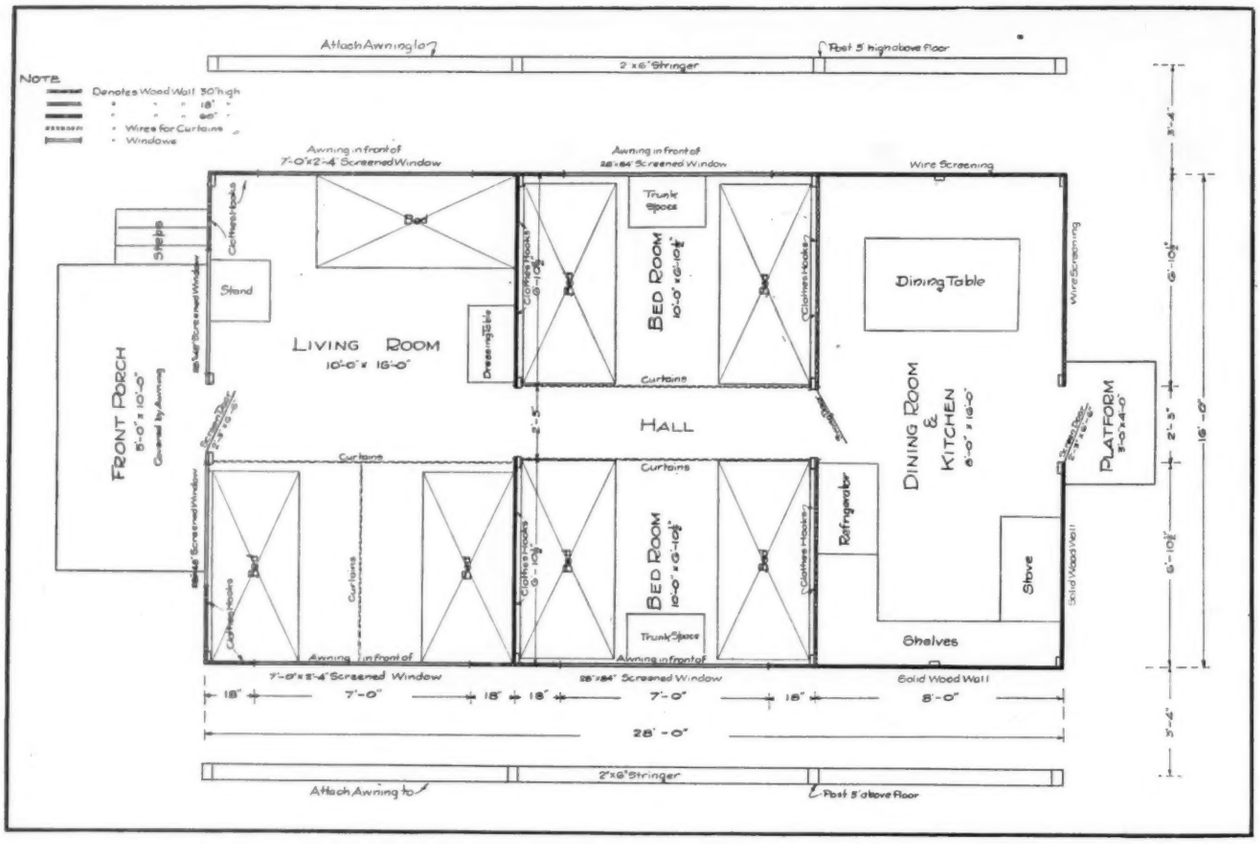
Some of it, of course, had to be carried the maximum distance, and one section of the reservoir wall was left open until the very last to permit the trains to pass through; but the locomotives did their part well, the work progressed rapidly and economically right through to its conclusion and modern industrial haulage has another success to its credit.

SEWER DESIGN AND CONSTRUCTION

Water Supply and Sewerage of Recreation Camps at Lake Geneva, Wisconsin

By W. S. Shields, Consulting Engineer, 8 South Dearborn St., Chicago

The engineer called upon to design sanitary improvements for summer outing camps finds it difficult to find much printed matter containing suggestions or requirements relative to the matter. The writer has had an opportunity not only to work out plans for such improvements, but to see them installed and to watch their maintenance through years of operation and to remedy defects and add improvements thereto.



PLAN OF HUT AT RECREATION CAMP, ALSO SUITABLE FOR USE IN CONSTRUCTION CAMPS.

Three Camps at Lake Geneva

At Lake Geneva, Wis., one of the most beautiful of the lakes accessible to Chicago's people, may be found several such camps. Three in particular are here mentioned, viz.: The Y. M. C. A. Training School, the Eleanor Association and Olivet Institute. The Training School has a capacity for caring for some 800 guests. They provide tents accommodating eight persons, four beds, and eat at a central dining hall. The Eleanor Club is a working girls' club of Chicago, and the camp is managed to give the girls some two weeks of outing at cost. They use a four-bed tent similar in size and arrangement to those at the Y. M. C. A. This camp has a capacity for accommodating some 200 girls and attendants.

The Olivet Institute is a religious organization doing an important work among the foreign element of the city. Its work is in one of the most thickly populated districts of mixed foreign element, a veritable melting pot of the nation. The institution has a yearly budget of some $50,000, and besides providing educational, medical and other public welfare work, has acquired a holding on the shores of Lake Geneva, where camp improvements have been made and where they are able to send the women and children of its parish out for a few days' outing. In order to maintain this expense they have also provided accommodations for pay guests, who are housed in four-room tents, as at the other camps, and fed at a central dining hall; they have also provided a number of tents and huts where families do housekeeping. These families, generally well-to-do people, come and spend from one to two months during the summer season. The camp has facilities for caring for some 200 or 300 guests.

The three camps are all located near each other on the northern shore of the lake. The shore is wooded and rather broken, extending back to a bluff which is 100 or more feet high at a distance from 500 to 1,000 ft. and more from the shore. The occupied section is along the shore where the ground is suitable for habitations.

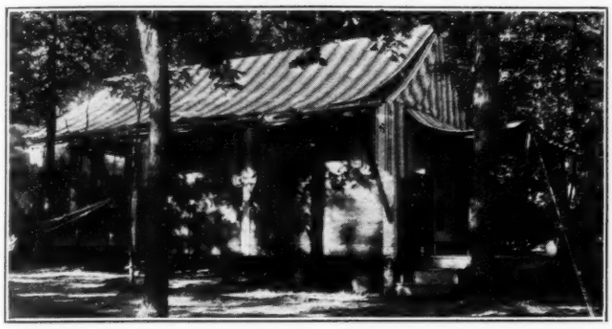
Water Supply

Extensive gravel beds are found in the banks and many springs entering the lake at short intervals supply drinking water and keep the lake pure and fresh.

The camps are supplied with lake water for general use; it is pumped into concrete reservoirs built in the hill back of

the camp and distributed by small pipes laid just beneath the surface to faucets, each of which supply three or four of the tents and huts. The pipes are arranged to be drained during the winter and a main cast-iron pipe leading from the pumping station to the reservoir is generally located so as to furnish water to fire hydrants at important points.

Drinking water is obtained from the springs or from wells. At the Y. M. C. A. camp a heavy flow spring, which comes from a bank near the water level of the lake, is lifted by a small water lift pump, operated with water from the main reservoir; this pump lifts the spring water into a separate concrete tank placed to such an elevation that it is carried to the kitchen, dining rooms and drinking fountains by gravity. At the Olivet camp the drinking water is secured from a spring at



TYPE OF HUT FOUND SATISFACTORY AT LAKE GENEVA RECREATION CAMPS AND SUITABLE FOR USE OF ENGINEERS AND CONTRACTORS IN CONSTRUCTION CAMPS.

a sufficient elevation so that it is conveyed into a concrete reservoir feeding the camp by gravity, while at Eleanor the drinking water is at present supplied from a well pumped by hand.

Sewerage

As the entire slope leads directly to the lake the question of sewerage was the most difficult one. This was accomplished by constructing tile sewers, mostly 6 in. in diameter, leading from the various toilets through septic tanks to a common point and to one side of the grounds, where a concrete storage tank is provided and from which the sewage is pumped back into the hill into a series of dry wells excavated in the gravel banks. The pumping plants consist of a combination gasoline pump and engine, which lifts the lake water into the reservoir; this machine is provided with a pulley for driving a small pump, which pumps the sewage from the storage tank, when filled, back to the dry pits. The pits are formed by excavating some 10 to 12 ft. down into the gravel beds and lining the pit, some 5 to 6 ft. in diameter, with a dry wall of sewer brick. By thoroughly cleaning these pits a month or six weeks prior to their being put into use, they have given excellent service through a period of 10 to 12 years.

After trying various and less expensive methods for outside closets and toilets the most satisfactory one, and that now universally adopted, is that of the standard low tank flush closet, and a sufficient number of these toilets, some for men and others for women, have been located at different points through the camps to be reached conveniently from all the tents. It has been found sufficient to provide one toilet seat for each 25 persons at the camp. The toilet buildings are of sufficient size to provide rest seats and lavatory bowls. In the camps where a large number of children from the tenement districts have been cared for the sanitary arrangements have proven entirely satisfactory and are a great source of comfort and security to the campers.

The writer has acted as chairman of the grounds committee of the Olivet camp for several years, and a study on the grounds of the needs and preference of the campers, has made it possible to meet the practical demands and to please the great majority of those who come from year to year for their summer outing.

Housekeeping Hut

The most popular housekeeping hut is that shown in the accompanying cut. This one is 16 ft. wide by 28 ft. long over all; board floor supported on posts, with sides walled with siding to a heighth of 30 ins., with 2x4-in. studs 5 ft. high supporting a 2x4-in. wall plate. Doors are framed in each end and supports provided for a ridge pole. This frame is then covered with a canvas tent and fly, the side walls of the tent drop to meet the side boards on the outside. Window openings 5 to 6 ft. by 28 ins. high are provided by constructing overlapping flaps in the side walls of the tent cover. These openings are formed of 2x2 uprights, extending from the floor to the wall plate, one on each side the opening, to which is attached on the outside a fly screen and a curtain rod on the inside for closing the opening when desired. The loose portion of the wall flap may be raised as an awning or dropped and the opening closed as desired.

The interior is divided off to suit the occupant; this plan shows a satisfactory arrangement. The partitions are of inexpensive curtain material supported on soft wire stretched across the tent, leaving a narrow passageway connecting the living room with the kitchen and dining room, which is boarded on one side and screened on the other.

The beds may be single cots or double-deck cots as desired. The association furnishes the cots, mattresses, chairs, table, gasoline stove and some dishes, the camper the rest of the necessary equipment. Huts of this type in ordinary times can be constructed for $150 to $175 each and will readily rent, including the outside conveniences furnished by the association, at $55 to $60 per season. This type of hut is also recommended for engineers' and contractors' use in construction camps.

The camps are daily inspected and stringent rules are enforced to maintain cleanliness and sanitary conditions. Garbage is collected daily and provisions delivered by local merchants and farmers.

Design and Cleaning of Sewer Catch Basins

Referring to the article published under this title on pp. 147 and 148 of MUNICIPAL ENGINEERING for April, attention is called to the fact that the address of the author, George A. Carpenter, is Pawtucket, R. I., instead of Providence, R. I., as given. Mr. Carpenter is, and for many years has been, City Engineer of Pawtucket.

Method and Cost of Making Tight Joints in Pipe Sewers

By W. W. Dixon, The Atlas Company, Lincoln, N. J.

National and state laws governing the pollution of streams with sewage have caused municipalities throughout the country to install expensive disposal plants for sewage treatment, and many of these plants, owing to topography, are compelled to install pumps to discharge the sewage after treatment. This is a very material item in the annual budget when we consider infiltration data as printed in Proceedings of American Society of Civil Engineers, Vol. LXXVI, and National Association of Cement Users, Vol. XII.

Importance of Reducing Sewer Infiltration

A vast amount of study and thought and a very considerable sum of money have been spent in the perfection of plants for the treatment of sewage. In a paper by Mr. W. H. Dittoe, chief engineer of Ohio State Board of Health, he places the cost of a disposal plant at 100 per cent. per capita above the cost of the sewer proper. Therefore, accepting the lowest estimate of experts on the amount of infiltration where cement joints are used, 33 1/3 per cent. of normal flow, we must nat-

urally increase the size of disposal tanks to treat ground water. Nevertheless, in the design of the sewer the cement joint is still very much in evidence, increasing the annual cost of maintenance. With the jointing cost of vitrified tile pipe sewer such a small part of the whole cost, and considering the known advantages and benefits deriving from a water-tight sewer, it is difficult to understand why a known leaky joint method is used, even if it is slightly cheaper than a material that will give results that will show an annual saving to the city. I have in mind one city in New Jersey where only a portion of the sewage reaches the disposal plant, this portion representing not more than 2,000 population, all dwellings, and the pumping records show in 1910-11-12 an average of 198,000,000 gals. pumped per year.

It is possible that I do not appreciate the fact that the tremendous infiltration of ground water through poor cement

DEMONSTRATION OF WATERTIGHTNESS OF G-K JOINTS IN SEWER PIPE. STOOD FULL OF WATER FOR 10 DAYS WITHOUT LEAKAGE.

joints dilutes the sewage, and, therefore, reduces the chances of pollution of streams if discharged before proper treatment due to the fact that the plant is not of sufficient size to care for the heavy flow, but on this point I do not consider myself qualified to present an opinion.

This condition has caused the writer to invent and introduce to the engineering profession G-K Compound, that has proven effective in stopping infiltration and at a cost no greater than if cement mortar were used.

Cost of G-K Joints

As to the question propounded of the cost of making G-K joints in vitrified tile pipe of the bell and spigot type, I take for example 8-in. standard pipe, the dimensions of which are known, having an annular space of ⅜ in. and a depth of compound of 1 in. This depth having been proven by tests to withstand a pressure of 29 to 35 lbs. per sq. in., means the material cost of the G-K joint at the price at which we are now quoting our compound, 1.69 cts. per joint. The advantage of G-K joint over cement joint is that (to use an expression that has lately come into vogue) it cannot be camouflaged. The cement joint, after the bevel has been wiped on the bell end, gives no evidence nor satisfaction to the inspector that the full annular space in the joint has been filled with mortar, as most specifications demand; while when G-K Compound is used, the inspector knows after a few joints have been made the volume necessary for a perfect joint, so he can stand on the edge of the trench and see that volume of compound poured from the vessel used, and has reasonable assurance that sufficient compound has been used to give a perfect joint.

Again, an item of saving in cost is evident. When two lengths are jointed on the bank, the joint so made sets up hard enough in a couple of hours to allow the lowering of two lengths as one into the trench, in this manner reducing the number of trench joints to one in four lengths of pipe, thus increasing speed in construction and the consequent saving in cost.

How Contractors Bid on G-K Joints

As to contractors' opinions on the subject of cost, we quote in Table I bids received at three lettings at Hagerstown, Md., where J. B. Ferguson, chief engineer, desirous of having work as nearly perfect as possible, called for alternate bids, the bid on G-K joint to cover 2-in. depth of compound:

Item 1—Vitrified tile pipe, per foot cement joint.

Item 1A—Vitrified tile pipe, 2-ft. G-K Compound.

The bids were the same in most instances, with exceptions in favor of the G-K joint.

A recent test was made by Thos. A. Bergen, city engineer of Auburn, of the use of compound. I do not know if G-K or some other compound was used, but the fact that the joints were poured joints and water-tight is the important item.

At Washington, D. C., John L. Rice, field commissioner of the Sewer Pipe Manufacturers' Association, made a demonstration of G-K poured joints before a group of government and city officials. He also made a demonstration at Columbus, O., which is illustrated herewith.

It is difficult to give cost data, as the average contractor does not consider the cost of jointing an important item, and reports we have received vary very materially, but with the known weight of G-K Compound per cubic foot and the known size of the annular space in the pipe to be filled, the actual material cost can be very quickly determined to a very small fraction.

An interesting article on the use of G-K Compound appeared in Municipal Engineering for September, 1912, entitled "Sewerage of Shelbyville, Ind." It gives no cost of jointing, but shows the saving to the contractor in pumping costs.

Eardley C. Cattley, resident engineer on the work at South Orange, Alexander Potter, C. E., New York City, designing and consulting engineer, places the cost of G-K joint in 8-in. deep and wide socket pipe at 14.68 cts. per joint 1½ ins. deep, but we must consider that at the time G-K Compound cost 6¼ cts. per lb., and the laborers using the compound were entirely unfamiliar with its use, and the sewer was laid below the ground water level in some cases, with a 3-ft. head. The infiltration was measured and only amounted to 400 gals. per sewer mile per day.

TABLE I—BIDS AT THREE LETTINGS AT HAGERSTOWN, MD., SHOWING HOW CONTRACTORS BID ON ORDINARY CEMENT AND G-K JOINTS IN PIPE SEWERS.

June, 1917

	Cement Joint					G-K Joint				
	27-in.	15-in.	10-in.	8-in.	6-in.	27-in.	15-in.	10-in.	8-in.	6-in.
A	2.80	.93	.55	.50	.40	2.90	1.00	.65	.60	.45
B	3.45	1.20	.60	.40	.33	3.45	1.20	.60	.40	.33
C	3.50	1.60	.57	.50	.45	3.40	1.55	.55	.48	.43

September, 1917

	24-in.	18-in.	8-in.	6-in.	24-in.	18-in.	8-in.	6-in.
A	2.75	1.75	.50	.40	2.75	1.75	.50	.40
B	2.90	2.15	.52	.44	2.95	2.15	.53	.45
C	3.07	1.80	.48	.38	3.07	1.78	.48	.38

January, 1918

	22-in.	18-in.	12-in.	10-in.	22-in.	18-in.	12-in.	10-in.
A	1.80	1.20	.70	.50	2.20	1.40	.75	.60
B	2.75	2.00	1.68	.45	2.75	2.05	1.68	.45
C	2.70	1.75	.98	.79	2.75	1.80	.99	.79

New York Ordinance Requiring Oil Separator for Excluding Gasoline from Sewers

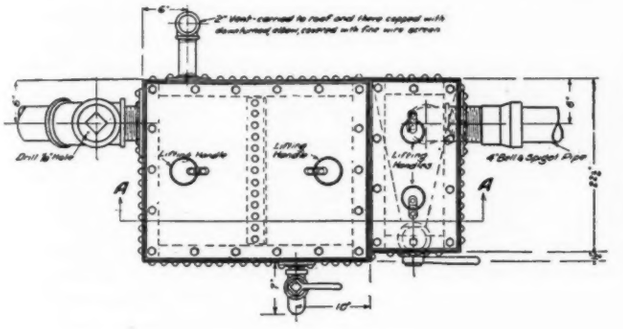
There is in force in the city of New York an ordinance requiring every garage where more than four motor vehicles are stored to install an oil separator or similar device to prevent gasoline from escaping into sewers where it would be likely to cause explosions. It is also prescribed that these separators be emptied and cleaned at frequent intervals. Owing to the precautions required by the ordinance the difficulties arising from gasoline in sewers have been much less than formerly. The ordinance requiring the separators has been declared constitutional by the Court of Appeals.

The New York fire department has issued plans, specifica-

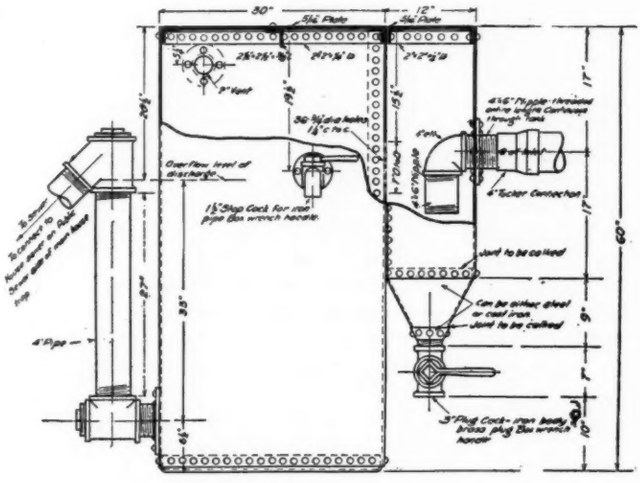
tions and regulations for an oil separator installation, the principal details of which are illustrated herewith.

Regulations Governing the Filing of Drawings, Descriptions, Etc., for Installation of Oil Separators

1. Drawings and triplicate descriptions, on forms furnished by the Bureau of Buildings and the Bureau of Fire Prevention for the installation of approved oil separators shall be properly filled in and filed by the owner or architect in the said bureau. The plans must be drawn to scale in ink, on cloth, or they shall be cloth prints of such scale drawings, and shall consist of a floor plan on which the separator is to be located, showing all windows and door openings, passages,



PLAN



SIDE ELEVATION & SECTION "AA"

PLAN, SIDE ELEVATION AND LONGITUDINAL SECTION OF OIL SEPARATOR TO KEEP GASOLINE OUT OF NEW YORK SEWERS.

walls, partitions, enclosures, stairs and elevator enclosures, location of boilers or other heating, lighting and power devices having an exposed flame or spark, gasoline storage system, exposures; a general floor plan showing location of separator, the various floor drain lines connecting to it, the relief, the discharge and its connection to the house sewer (if any), and that much of the house drain as will show the house trap and fresh-air inlet; a vertical section or sections showing this latter plan in elevation; a plan and as many elevations of separator and its connections as are necessary to show clearly in detail those connections; together with their various sizes, and, if the separator is located in pit, full details and dimensions of the same should likewise be shown. Ample clearance for inspection and maintenance between separator and pit must be shown.

2. The said installation shall not be commenced or proceeded with until said drawings and descriptions shall have been so filed and approved by the superintendent of buildings and the chief, Bureau of Fire Prevention.

3. No modification of the approved drawings and descriptions will be permitted unless either amended drawings and triplicate descriptions covering the proposed change or changes are so filed and approved by the chief, Bureau of Fire Prevention, and the superintendent of buildings.

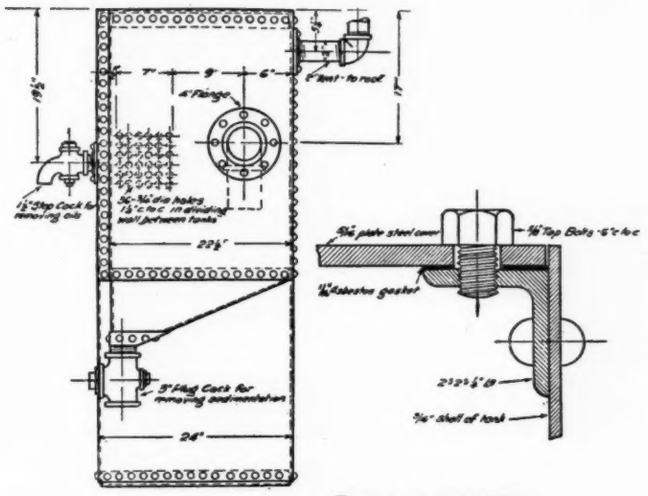
4. The installation in all buildings, both public and private, shall be executed in accordance with the rules and regulations of the Bureau of Buildings (all boroughs) and the Bureau of Fire Prevention.

5. Repairs or alterations of the separator and any other connection may be made without filing drawings and descriptions in the Bureau of Buildings and the Bureau of Fire Prevention, but such repairs or alterations shall not be construed to include cases where new vertical lines or horizontal branches of soil, waste, vent or leader pipes are proposed to be connected to the said separator.

6. Oil separators installed in any building where volatile, inflammable fluids are used, must be arranged to be readily accessible; where located underground, an iron, brick or concrete manhole must be provided with an iron or flagstone cover. They must not receive the discharge of house, outside court and area drains, toilets or leaders.

7. They must in all cases be connected by a Y-branch fitting to the house sewer on the public sewer side of house trap.

8. No separate trap need be provided on drain entering oil separators, but a running trap must be provided for each floor drain discharging to the separator.



DETAILS OF COVERS

ADDITIONAL DETAILS OF NEW YORK OIL SEPARATOR FOR KEEPING GASOLINE FROM ENTERING SEWERS FROM LARGE GARAGES.

9. When fixture or floor drains are located on any floor above the first, the lines to which they are connected must extend in full caliber at least 1 ft. above the roof coping, and well away from all shafts, windows, chimneys or other ventilating openings. When less than 4 ins. in diameter they must be enlarged to 4 ins. at a point not less than 1 ft. below the roof surface by an increaser not less than 9 ins. long, and the traps of all fixtures vented.

10. Relief pipes must be provided at least 2 ins. in diameter and carried independently above the roof, and there capped with down-turned elbow equipped with fire screen.

11. Drainage from washstand in garages shall not be permitted to flow into sump pits.

12. All piping must be left exposed until after the fire department inspections.

13. Oil separator pit shall be so located to prevent floor

drainage flowing into it, or else have concrete curbing around it.

14. Where a pit is below the ground water table and there is a possibility of water being in the pit, the lining should be made impervious.

Employing a Backfilling Machine of Special Design on Heavy Sewer Work in Chicago

When the Byrne Bros. Construction Company, of Chicago, took over the contract from the Sanitary District of Chicago for the construction of two sections of 17-ft. concrete sewer on the South Side, they worked out, in conjunction with the Weller Manufacturing Company, an arrangement by which each unit of expensive machinery employed on the job could work at the highest rate. By using the machine they devised,

SPECIAL BACKFILLING MACHINE USED ON HEAVY SEWER CONSTRUCTION IN CHICAGO.

the drag line excavators on the job were enabled to work from one position for a great length of time, thus cutting down the cost of moving.

The general method employed on this job was to have a steam shovel go down through the street and excavate a quantity of earth equal to the cross-section of the finished sewer.

This operation was carried out in the usual method, the shovel delivering the excavated material into narrow-gauge industrial railway cars and transporting it to a suitable dump or location requiring filling.

Following the steam shovel came the drag line excavator and the backfilling apparatus shown in the picture.

The drag line machine would start excavating from a point where the boom could be used to its maximum capacity. Then remaining in this one position, it would continue to dig out the full amount of dirt required for the installation of the sewer.

After a suitable length of ditch had been obtained, approximately 50 ft., the work of putting in the sewer commenced, and from this time on a comparatively continuous cycle of operation was carried out. The drag line machine would dig as fast and as hard as the operator could make the machine go.

From the one position the bucket would swing back and forth from the excavation to the hopper, which is located at the end of the backfilling machine. Because of the reach of the boom, the drag line excavator could stand in this one position for several hours.

Regardless of the material or of the size of the lumps handled, the operator would dump his load into the receiving hopper, whch was about 10x12 ft. long. The top of this hopper was made of heavy steel. Along the bottom was an endless feeder made of heavy steel overlapping pans, carried on two strands of heavy roller chain, which fed the clay at a speed of about 15 ft. per minute from the bottom of the hopper through a system of rotary knives.

These rotary knives or disintegrators took lumps 2 ft. or 3 ft. square and 4 ft. long, and reduced them to a size easily handled by the belt conveyor, which ran back from the feeder parallel to the excavation. This belt conveyor was rather an unique equipment, in that it was mounted on a series of industrial railway cars, thus making the whole outfit portable.

This conveyor, which was 40 ins. wide and 150-ft. centers, carried the dirt down back of the point where the men were building the sewer to a point where the concrete had already set and was ready for backfilling. Here it discharged the material on to a cross-belt or boom, which carried and distributed the material out over the finished sewer.

This system does away with much handling and rehandling of material for backfilling, which is usually done at a high cost, but the greatest points of interest to contractors are the speed and continuity of operation of the various parts, and the fact that the entire operation can be carried on within the street lines.

Ordinarily the rate of progress in a sewer of this description would be about 15 ft. of finished sewer per day, while by use of one of these machines no trouble was found, it is claimed, in getting from 30 to 35 ft. per day.

The mechanism is a comparatively simple one and is constructed throughout of heavy equipment built to withstand the shocks, rough usage and ordinary abuses found in all contracting work of this character. The entire equipment worked out in a satisfactory manner.

The Prince of Denmark on Catchbasin vs. Inlet

(As reported to M. E. by G. A. C., Pawtucket, R. I.)

Catchbasin or inlet—that is the question:
Whether 'tis better for the mind to favor
The building, care and maintenance of basins,
Or to take up arms against this sea of troubles,
And just build gutter-inlets. To dare to clean
No more, and, by that act, to say we end
The nuisance and the many natural shocks
These basins give us. 'Tis a consummation
Devoutly to be wished. To act, to sleep—
To sleep, perchance to dream. Ay! there's the rub!
For in that peaceful sleep what dreams may come,
After we have filled all those old basins,
Must give us pause. This is the thought
That makes us hesitate in building inlets;
For who would bear the gibes and jeers of man
Caused through mistake, the proud man's contumely,
The pangs of anxious doubt, results delayed,
The politician's keen, exhaustive search?
That, patient, bides such opportunity,
When he himself might his contentment have
By simply building basins.

Performance Data on Auto Eductor for Cleaning Sewer Catch Basins

Some very creditable records have been made by the Otterson Auto Eductor, here illustrated, in cleaning sewer catch basins. The truck with eductor and all attachments is built by the Kelly-Springfield Motor Truck Co.

The eductor consists of a 4-in. telescopic pipe, with a horizontal discharge branch at the top. At its lower end is an elbow connected to a 3-in. pipe from which a hose is led to the discharge of a centrifugal pump. A 1-in. nozzle from the 3-in. pipe is led into the 4-in. pipe, where it is turned upward. The 14-in. centrifugal pump is mounted on the side of the truck frame and its suction is connected to the body of the truck. It is driven by a link-belt chain from a power takeoff attached to the driving shaft of the truck. The sprocket on this shaft runs idle normally and is engaged by means of a lever near

the driver's seat. A pressure gage enables the driver to regulate the motor to give the proper speed and pressure at the pump. The ratio of the spockets is such that the required pressure of 40 to 50 lbs. is obtained at a low motor speed. The body of the truck is a watertight steel box. Its tail gate is hinged at the top and is made watertight by means of clamp bolts which press a rubber gasket against the end frame. An opening in the bottom provides for the attachment of the inlet valve on the pump suction, and an opening in the side provides for the overflow valve. Within the body is a frame carrying transverse hinged baffle plates, and having a longitudinal partition plate extending the full length of the body. The 8½in. space between this partition and the side of the truck is called the clear-water compartment. The first three baffles extend only to the partition and have openings in the upper portion so spaced as to cause the flow of water and refuse to travel far. By this means most of the solid matter settles before the flow reaches the end baffle. This last baffle plate extends the full width of the body and is pierced with ¾-in. holes. Thus the flow is screened as it passes out of the main part of the body and again as it enters the clear-water compartment, with which the pump is connected. Spacers hold the baffles in position when the tail gate is closed. The opening of this gate releases the spacers so that the baffles can swing back and give free discharge to the contents as the body is dumped.

The machine can be converted into an ordinary truck for handling stone, gravel and other material. For this purpose the bottom is made of heavy plate, the baffle frame is removable and the two valve openings can be closed by bolted covers. In starting its work the truck, with body partly filled with water, is run close to the catch basin. The eductor arm is loosened and run out to position over the manhole and then the telescopic pipe is lowered until it rests on the refuse in the catch basin. The pump is then started, drawing water from the truck body and discharging it into the 4-in. pipe through the 1-in. nozzle at 40 to 50-lbs. pressure. This upward jet causes the refuse to flow into the pipe, where it is carried up and discharged into the truck. There the solid matter settles and the water comes back through the clear-water compartment to the pump.

George E. McCrath, Superintendent of the Bureau of Sewers, Chicago, reports the work performed by the Auto Eductor for the months August, September and October, 1917, as follows:

Cost of Operation

One chauffeur, 3 months at $115 per month	$345.00
One laborer in charge of auto crew, 2 months at $3.60 per day	176.78
One laborer in charge of auto crew, 1 month at $4.60 per day	112.95
One laborer in charge of auto crew, 3 months at $3.30 per day	243.08
Total for labor	$877.81
Repairs, gasoline, oil, etc	$308.08
Interest at 4% on $7,000 (cost of Eductor)	70.00
Depreciation at 10 cts. per mile for 1,380 miles	138.00
Grand total	$1,393.89

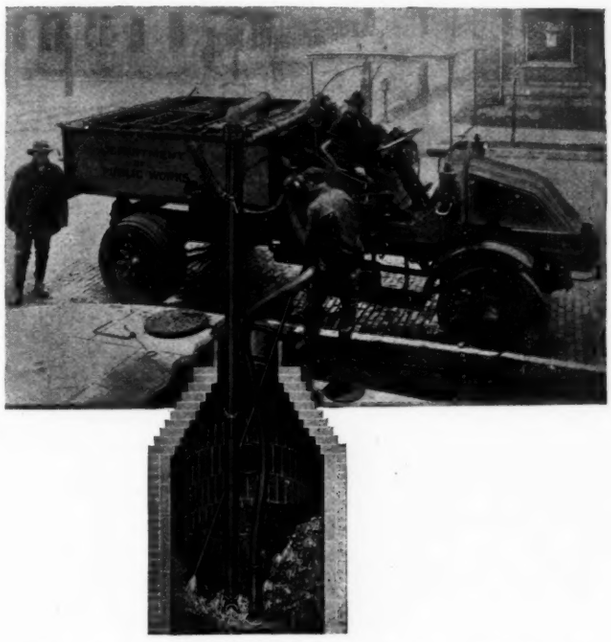
Work Performed

Number of miles traversed	1,380
Number of catch basins cleaned	1,073 at $1.299
Number of cubic yards removed	1,763 at .79

The average cost for cleaning catch basins during the past four years was $3.24 each. Using this price for comparative purposes it appears that the city has saved $2,082.63 upon the work performed by the Auto Eductor during the three months of operation.

In March, 1918, Chicago purchased six more of these machines; this increase in equipment is the result of the above record of performance.

During the first six days one of these machines was operated in Louisville, Ky., by a driver and two laborers unfamiliar with it, it cleaned basins at an average cost of 69 cts. each as compared with $3.40 by hand. The sanitary advan-



VIEW OF AUTO EDUCTOR EQUIPMENT FOR CLEANING SEWER CATCH BASINS.

tages of the machine were equally superior to the results secured by hand methods. During these days, in freezing weather, an average of 25 basins were cleaned in 9 hours. This figure, it was expected, would be increased to 75 after the first thorough cleaning.

At Portland, Ore., the performance of the machine was as follows:

Average number of basins cleaned per day	100
Average size of basins	1½x2x4 ft.
Wages of truck driver	$3.75
Wages of 2 laborers at $3	6.00
Total cost per day	$9.75
Average cost per basin	.10

At Indianapolis, Ind., time tests showed that the machine could clean a basin 9 ft. deep and 4½ ft. in diameter, full of heavy dirt and mud to the outlet of the basin, in 8 minutes.

Delivering Trucks Overland

Eastern distributors of "Schacht" worm drive trucks will not suffer any inconvenience on account of the existing railroad conditions. The G. A. Schacht Motor Truck Co. is shipping its trucks by rail to Pittsburgh, and its dealers in New York and eastern states are running them overland from Pittsburgh to destination. The company had at first decided to run the trucks overland from the factory to destination, but it seems the arrangement mentioned above will work out to the best advantage and keep all the dealers supplied with enough trucks for their requirements, which are increasing every month.

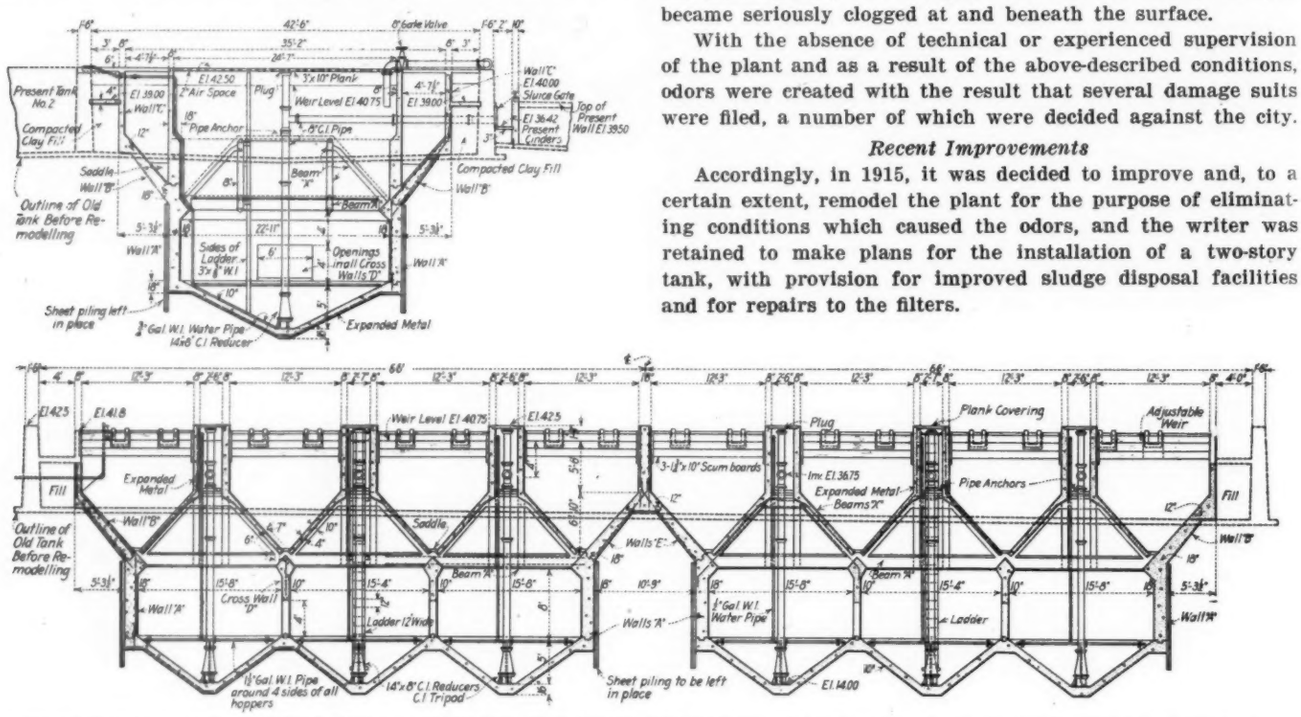
WATER PURIFICATION AND SEWAGE TREATMENT

Recent Improvements to Sewage Treatment Plant at Alliance, Ohio

By R. Winthrop Pratt, Consulting Engineer, 716 Hippodrome Building, Cleveland, O.

Alliance is a rapidly growing industrial city with a population of at least 25,000, located in the northeastern portion of Ohio on the main line of the Pennsylvania Railroad. The city is well supplied with modern public improvements, including a water supply, a water filtration plant and a fairly complete system of sewers, built on the separate plan. However, the roof water from many dwellings has been allowed to enter the sanitary sewers, so that the sewage flow has been found to vary from a minimum, during dry weather, of about 2,000,000 gals., to a maximum, during storms, of 5,000,000 gals. per 24 hours.

The Mahoning River, which flows through the northern part of the city, furnishes the water supply as well as the outlet for the treated sewage effluent from the city. This stream has a very low dry weather flow, so that thorough treatment of the sewage is necessary to prevent a nuisance.



TRANSVERSE AND LONGITUDINAL SECTIONS THROUGH SEDIMENTATION TANKS OF IMPROVED SEWAGE TREATMENT PLANT AT ALLIANCE, OHIO.

History of Sewage Treatment at Alliance

The first sewage disposal plant installed at Alliance was in 1893. This was one of the earliest plants in Ohio and was of the chemical precipitation or lime treatment type. This plant became outgrown and was unsatisfactory. It produced, in its overloaded condition, an effluent which caused a representative of the State Board of Health to report that "the lime treatment at Alliance does not measurably reduce the organic and polluting character of the crude sewage."

In 1913 there was placed in operation, at a different site, a new plant comprising grit and screen chambers, three single-story open sedimentation tanks, 9.5 ft. deep; twelve 5-ft. contact beds of ¼-acre each, and four 1-acre intermittent filters, one of which was intended for a sludge drying bed. Locomotive cinders were used as a filtering medium. The contact beds were filled with the coarser cinders and the fine-grained filters with the screenings and very fine material.

Soon after starting certain operating troubles developed. These related chiefly to the removal of sludge from the sedimentation tanks, to the offensive condition of the sludge and to drying the sludge on the bed provided therefor. Also, there formed rapidly at times, on the surface of the liquid in the tanks, a thick scum or mat, which was more or less offensive; and, furthermore, by reason of the excessive wet weather flows in the sewers, this scum together with some of the deposited sludge, was swept out of the tanks and on to the contact beds. By reason of this, and also on account of the occasional presence of large amounts of suspended matter in the tank effluent, due to septic action in the tanks, the beds became seriously clogged at and beneath the surface.

With the absence of technical or experienced supervision of the plant and as a result of the above-described conditions, odors were created with the result that several damage suits were filed, a number of which were decided against the city.

Recent Improvements

Accordingly, in 1915, it was decided to improve and, to a certain extent, remodel the plant for the purpose of eliminating conditions which caused the odors, and the writer was retained to make plans for the installation of a two-story tank, with provision for improved sludge disposal facilities and for repairs to the filters.

The plan adopted for the improved plant included: (1) The conversion of one of the three sedimentation tanks into six two-story tanks of the Imhoff type, with minor changes in the other two tanks; (2) the construction of new glass-covered sludge beds within the area occupied by one of the fine-grained filters; (3) the construction of a new fine-grained filter and covering some of the others with a layer of sand; (4) the installation of ejector equipment for transferring the sludge which accumulates in the old sedimentation tanks into the sludge digestion compartments of the Imhoff tanks, and thence, after digestion, onto the new sludge beds; (5) improving the contact beds partly by washing and replacing the cinders and partly by replacing the cinders with slag; and (6) miscellaneous minor improvements. During the entire con-

struction work, which occupied about twelve months, the sewage was allowed to flow through at least one of the sedimentation tanks. The work was divided into three contracts, as follows:

Contract No. 1—Remodeling of tanks and installation of pumping and ejector machinery.
Contract No. 2—Washing and replacing filtering material and miscellaneous minor improvements.
Contract No. 3—Glass-covered sludge beds.

Tanks

After deciding to install a two-story tank, a type which had come into use since the original design of the plant, the question came up as to how the existing tanks could be used to the best advantage. These tanks, which had a total capacity of 1,000,000 gals., equivalent to 8 hours on the nominal flow of 3,000,000 gals. per day, afforded an excellent means of clarifying the sewage as long as there was no marked septic action.

The best solution seemed to be a plan whereby two of the tanks were retained as sedimentation basins, while the third was changed into a two-story tank having sufficient sludge storage capacity to digest sludge which would be produced by all of the sewage treated, thus retaining the advantages of the old tanks as regards sedimentation, but an improved means of removing, digesting and disposing of the sludge from these tanks. The flow chamber capacity of the new tanks was made simply large enough to treat about 50 per cent of the total flow on the basis of two hours' sedimentation.

The sewage flow would be split about equally between the new tanks and one of the old ones, while the other old tank would be standing empty or being cleaned. This tank will serve, furthermore, to take the excessive flows which occur during wet weather on account of down-spout connections and leaky sewers, thus preventing excessive rates through the tanks handling the dry-weather flow.

When the sludge deposited in the old tanks begins to become septic and interfere with sedimentation, it is the plan to drain the supernatant liquid—that is, the upper nine-tenths of the tank—out onto one of the fine-grained or low-level filters, and to pump the sludge by means of an ejector into the digestion chamber of the two-story tanks. During this operation, of course, the sewage flow through that section of the tank receiving the sludge will be cut off.

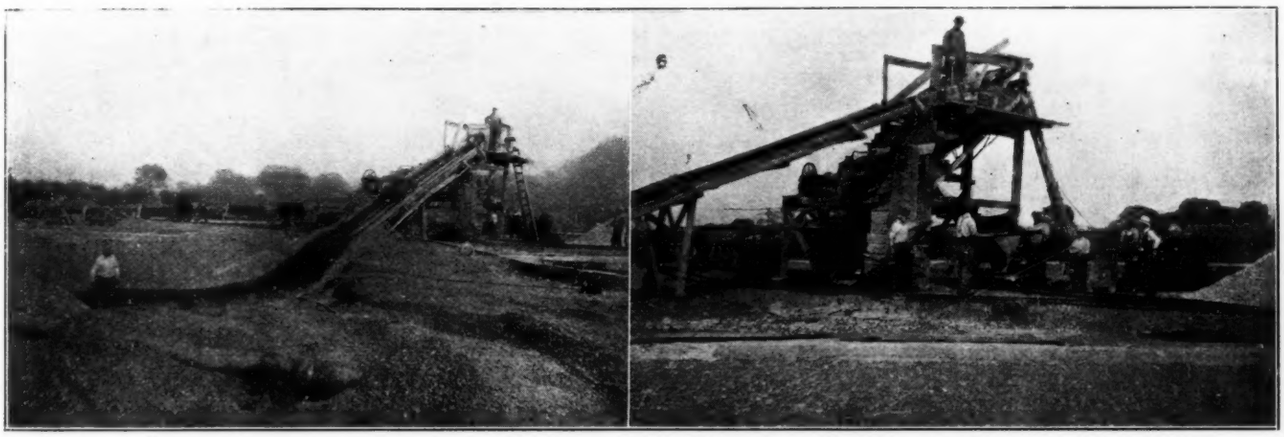
In the sedimentation tank which was remodeled, most of the bottom was cut out and a group of six two-story tanks built entirely inside as a separate structure and to a total depth of 28.5 ft., or 18.5 ft. deeper than the original tank. The feature in this construction was, of course, the care required to prevent the undermining and settling of the existing walls. The design of the new tanks took this into consideration. The earth was retained by driving a double row of wood sheet piling 8 to 9 ft. distant from the inside of the existing walls, which piling was left in place and used as a form for the walls of the sludge compartment. The material was a rather wet clay, and the method used was entirely successful. The tanks were also designed so that the flow compartment walls securely braced the walls.

Another feature was the utilization of the existing walls of the old tank as walls for the new flow channels.

A 200-gal. per minute air ejector was placed in a separate chamber constructed in one of the contact beds adjacent to the tanks, for the purpose of raising the sludge from the old tanks into the digestion chamber of the new. On account of the depth of the new tanks it was also necessary to lift the sludge to the sludge filters, and this was likewise done by means of an air ejector having a capacity of 100 gals. per minute.

Contact Beds

Preliminary studies were made to determine the location and extent of clogging in all of the beds. Each bed was filled with sewage, the volume of sewage required being carefully measured in order to determine the percentage of voids. The time required to empty the bed was then noted, by taking measurements of the level of the water every half hour. Also, pits were excavated in the material at various points to observe the character of the clogged material. The cinder filtering material in the bottom of several of the contact beds was found to be so badly clogged that it was considered necessary to remove it.



VIEWS OF PLANT FOR WASHING AND SCREENING DIRTY CINDERS FOR SEWAGE BEDS, ALLIANCE, OHIO.
Dirty Cinders Hoisted Over Runway in Slip Scraper to Elevated Platform, Dumped into Screen, Washed While Screening, Discharged into Industrial Cars and Transported Back to Beds.

There were estimated, by means of the above observations, the approximate quantities of material to be removed and either discarded, or screened or washed and returned to the beds. The treatment necessary was, of course, varied as the beds were excavated and the actual condition of the bulk of the material more readily observed. It was found on completion, however, that the preliminary estimates were ample to cover the amounts of material which had to be handled.

Incidentally, it is interesting to note that the condition of the beds as regards freedom from clogging was found to improve during the several months of rest period given some of the beds while the work was under way, due to the drying and disintegration of the sludge. However, it was found that where the clogging had been greatest the cinders contained much dust and fine material, which would have caused further clogging after again receiving the sewage.

Washing and Replacing Cinders

An interesting feature of the construction was the method employed for removing, washing and screening and returning the cinders to the beds. This process is shown by the accompanying photographs. The dirty cinders were transferred di-

rectly to an elevated platform over the screen by means of a scraper, runway and hoist, and were dumped directly into the screen, which was of the horizontal, cylindrical type, with ⅜-in. openings, having a water pipe extending along its axis. The water pipe, which was perforated, played the water on the cinders in sufficient quantity thoroughly to wash them before they left the screen. The washed and screened cinders were discharged into industrial cars and thence transported back to the beds.

The new material for the contact beds consisted of ¾ to 1½-in. slag for the main portion of the beds and ½ to 1-in. gravel for placing around the distribution pipes. This material was transported from the railroad siding, about 1,800 ft. distant from the plant, by means of industrial cars loaded from bins at the siding, and was dumped directly into the beds, the industrial tracking being carried onto the beds along the concrete dividing walls.

Secondary Filters

To improve the secondary or fine-grained filters, which were composed of cinders, it was found necessary only to remove about 4 in. of cinders from the surface of the beds and to replace this material with clean, coarse sand. Two of the fine-grained beds were improved in this way. The sand was transported and placed in the same manner as the slag and gravel. Also, to provide additional filtering area, a new fine-grained filter of similar material was constructed in the space originally planned, but not previously utilized for this purpose.

Sludge Beds

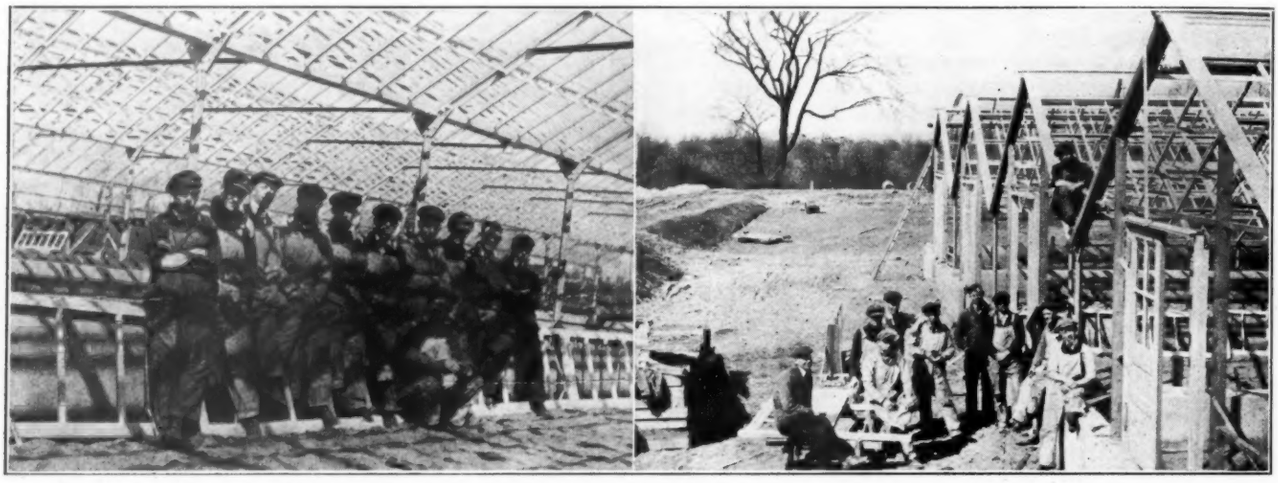
It was decided to utilize for the construction of the new sludge bed a part of the fine-grained filter formerly used for drying sludge. Accordingly, 12 in. of the dirty cinders were removed from the top of this filter, concrete curb and dividing walls constructed, extending through the cinders to solid ground, and 9 in. of clean sand and 3 in. of gravel placed over an area of ¼ acre. Industrial tracks for the removal of dried sludge were placed along the center line of the beds and extended on the outside at both ends, the length of the original filter. That portion of the old filter not occupied by the new sludge bed is still available for sludge drying.

Glass Covering

The sludge beds were provided with glass covering of the greenhouse type of construction. This was done for aesthetic reasons, as well as for the practical reasons of preventing the possible spread of odors from improperly digested sludge and of permitting the drying of sludge to continue in all kinds of weather.

Of distinct interest from a practical standpoint was the method of taking bids and awarding the contract for this covering. Instead of designing the structure in detail before inviting bids, several reputable greenhouse companies were invited to submit plans and specifications for their standard types of construction. From these a general type of construction was decided on and plans and specifications prepared and made sufficiently general to permit competitive bids based on standard construction. This undoubtedly saved considerable money for the city, because it permitted, within limits, the use of the standard lengths and sizes of the successful bidder. The plan also tended to secure highly skilled and experienced workmen.

The glass covering comprised a rigid steel framework and wood sash, the latter hinged at the top and connected to operating apparatus arranged for opening and closing all of the sash from central points on the walls of the sludge beds.



VIEWS OF GLASS COVERING OF GREEN-HOUSE TYPE OVER SEWAGE SLUDGE BEDS, ALLIANCE, OHIO.
Rigid Steel Framework and Wood Sash Hinged at Top and Connected to Operating Apparatus.

Personnel

The improved sewage treatment plant was designed and constructed under the direct supervision of the writer, with the assistance of R. F. MacDowell and R. E. Garvin. H. H. Hampton, H. A. Cooke and R. J. Auld, Jr., were inspectors. Contract No. 1, for the tanks, was awarded to the Henderson Construction Company, of Youngstown; Contract No. 2, for the contact beds, to Homberger & Wagar, of Sandusky, and Contract No. 3, for the glass covering, to the King Construction Company, of North Tonawanda, N. Y.

The Ozone Method of Water Treatment and Some Examples of Recently Installed Industrial Plants

By Irwin D. Groak, Consulting Engineer, Monadnock Block, Chicago

The oldest method known for water purification is by storage. A body of water kept in basins from 10 to 30 days is affected by sunlight. The bacteria are reduced considerably and the matters in suspension settle to the bottom of the basin. Naturally, unless the basin is cleaned regularly, the effectiveness of this crude method is reduced.

Characteristics of Other Processes

Sedimentation, assisted by chemical coagulation, is effective. The objection to this method is the large initial expense and upkeep of the grounds and buildings, and that some of the chemicals will remain as a residue in the water, leaving taste and some odor. It is interesting to know that there is not a single sedimentation plant which is better than 98 per cent. efficient. Some of the harmful bacteria will get through.

Slow sand filtration is one of the natural methods for getting clear water. It does not kill all the bacteria, but takes out the matter in suspension. Old filters become inefficient and need cleaning. They require a large acreage, and if they

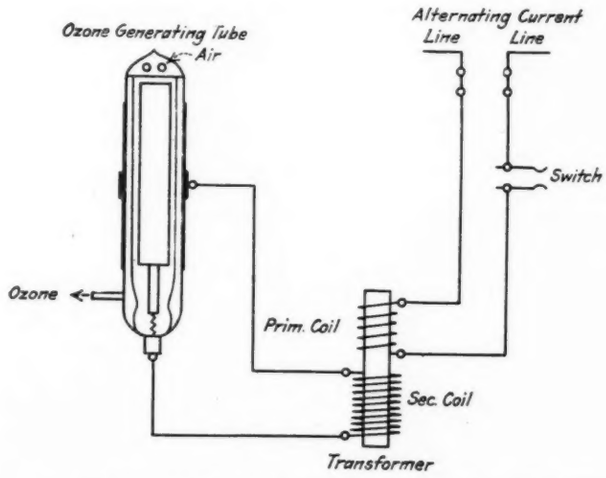


FIG. 1—DIAGRAM OF EFFICIENT AND INEXPENSIVE OZONE GENERATOR.

are not covered they will freeze in winter. While they take out a good deal of the impurities, the water is not absolutely safe for drinking.

Mechanical filtration is a more modern method than slow sand filtration. It does the work in less time and in less space, but is not absolutely safe by itself, and can be considered only as a part of water purification.

Chlorine and hypochlorites are good germicides. They do kill the germs. Objectionable features to their use are that they have a taste and odor, and overdosing may become dangerous for the human system. There is a chance of the water giving rise to a dark color, as organic matters form compounds, with especially disagreeable odors and tastes. Also, it is proven that there is an aftergrowth of bacteria in the tap water in many cases.

The methods of sterilization include distillation, which can be done only on a small scale, but this takes out the mineral qualities of the water and we get only H_2O. Boiling the water can be done only on a small scale. The boiled water is flat. The impurities, both organic and inorganic, and the matters in suspension, remain in the water; also, the killed bacteria. This is merely a makeshift for the household.

The ultra-violet-ray method of sterilization is effective, provided the water is carefully filtered and the lamps are made right and the water flows around the lamps without any shadow being created. It does not remove organic matter, bad odors or taste of chlorine.

The method which has stood the test is the treating of water with ozone.

Development of the Ozone Process

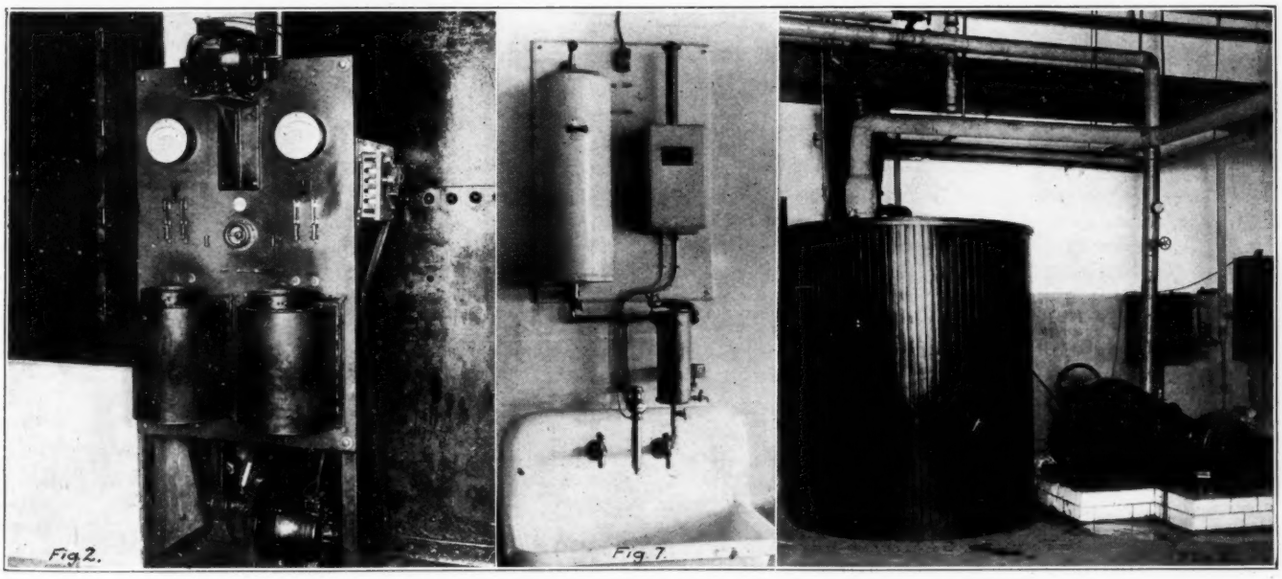
Ozone is the strong, powerful gas, O_3. For water purification it was used first by Schoenbein in about 1849. The project was taken up on a commercial scale by Siemens & Halske in 1898, and in a short time thereafter a number of plants were installed in Europe, and today about 60 or 70 large municipal plants are using the ozone method of water purification, in Germany, France, Italy, Russia, Roumania, and even in South America.

The first plant was in Paderborn, Germany, where typhoid fever has entirely disappeared from the town. Petrograd, Russia, and Munich, Germany, use ozone for large breweries and industrial plants, and Astrachan for sterilizing mineral water. In France alone, in 1915, there were 26 plants working, including that of Paris. Besides Siemens & Halske, Tindal, whose patents passed into the hands of M. de Frise, who improved on them, also Otto, and several others worked and made improvements. Vosmaer spent about 15 years of scientific study on the use of ozone for water purification and other industries.

The application of ozone in water treatment depends on the properties of the water itself. It is preferable to use rough filtration in order to make the water clear of matters in suspension. It makes quite a difference for the designer of a plant whether he has to contend with river water, lake or well supply. Ozone itself, if properly handled, will reduce the turbidity due to organic matters about 70 per cent., but it is cheaper to do that with rough filtration, and let the ozone act on the bacteria and organic impurities.

Nature of the Process

How does ozone act on the water? Just as in nature. Both before and after a rain we smell ozone; the air is charged with it. The rainwater comes in drops; every part of it is touched by the ozonated air.



VIEWS OF THREE TYPES OF OZONE PLANTS FOR TREATING INDUSTRIAL WATER SUPPLIES.
Left to Right: Fig. 2—Part of Installation Used for Six Years in C. B. & Q. Ry. Office Building in Chicago. Fig. 7—Type Used in Residences and Small Factories. Fig. 3—Another View of Same Installation Shown in Fig. 2.

Science has put into commercial form the imitation of this occurrence. We all know that through either seepage, vegetation or sewage contamination, there is hardly any water which is not contaminated with harmful bacteria. Ozone mixed with this water will discharge one part of oxygen in so-called status nascendi. This part of oxygen makes a combination with the

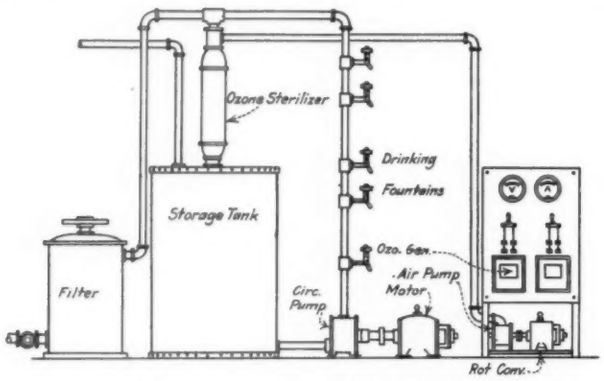


FIG. 4—OZONE PLANT INSTALLED AT PHOENIX KNITTING WORKS, MILWAUKEE.

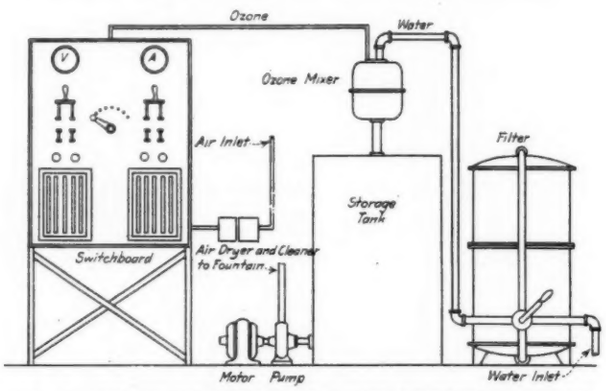


FIG. 5—OZONE INSTALLATION FOR SCHOOLS, PUBLIC BUILDINGS AND SMALL INDUSTRIES.

carbon of the organic impurities, burning them up into CO_2, and literally removes the harmful and odor bacteria from the water and produces not only a safe, but palatable, crystal clear, oxygenated water.

Naturally it took some time before a process was worked out on a commercial scale in such a way that now it is possible to produce and to manufacture an apparatus for a reasonable amount and small upkeep. The most important part of the equipment is the ozone generator. The Electric Ozone Sterilizer Company, of Chicago, claims to have an efficient and inexpensive ozone generator, consisting of a vacuum tube, which is made from glass—see Fig. 1. Around this vacuum tube there is another glass with metal contact. About 5,500 volts or more of alternating current, in passing through there, produces a silent discharge of electricity. The proper name is brush discharge; sparking would produce nitrites, which are harmful. This brush discharge makes ozone from air. Conveying this ozonated air into the mixing chamber or sterilizing towers is another secret of reproducing nature's own water purification.

It is not only important to have pure ozone and have a simple device for making the ozone, but equally as necessary to have an efficient mixing device to use up every particle of the ozone and to make sure that all molecules of the water shall be thoroughly mixed and in touch for at least a short period, by passing the water through the mixing or sterilizing chamber. The air should be filtered and dried before entering the ozone generator. The ozone exercises a selective action. First it destroys the pathogenic, less resistant bacteria. On a commercial scale it is not advisable to go too far with the process. To give an idea of how much ozone is required to treat the water, anywhere from one-half to three grams per cubic meter of air is the general method for concentration. Regarding the output of ozone per horse-power employed, 25 to 30 grams, sometimes even up to as high as 35 grams, is an average for rate of production.

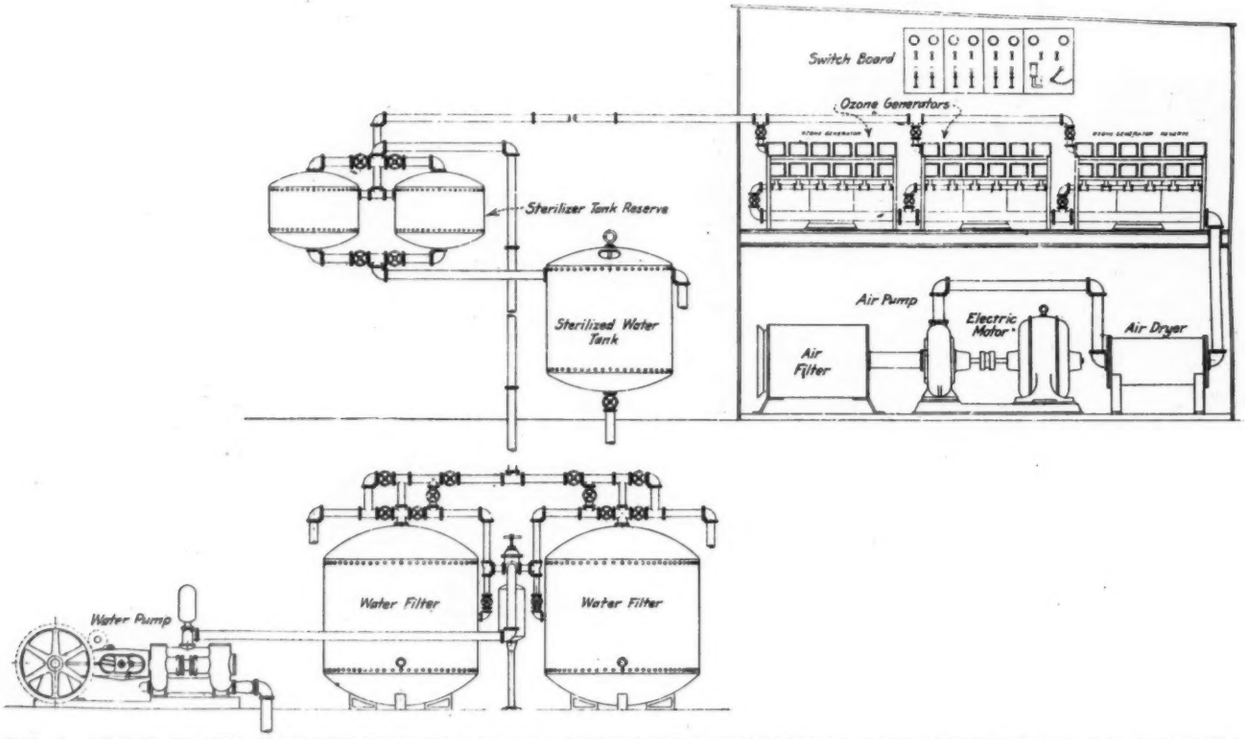


FIG. 6—OZONE WATER PURIFICATION PLANT OF LARGE SIZE, SUITABLE FOR USES OF CITIES AND LARGE INDUSTRIAL PLANTS.

If the air is cooled the results are better than with warm air. On large installations it is advisable to use a refrigerator. The above amount of ozone per hour, according to the contents of the water, is enough to sterilize from 400 to 1,800 gals. of water.

The Process as Viewed by European Authorities.

Quoting from Don & Chisholm, of "Modern Methods of Water Purification," pages 202-3, they say: "Naturally, a purification process which converts an unwholesome stream into a liquid as certainly inoffensive as the purest spring water is one that appeals directly to water undertakers. * * * The consumer cannot find fault with the treatment, for no residue of the purifying agent is left in the tap water. * * * It is an ideal procedure."

With reference to the treatment of river water, we are quoting the following: "The results obtained were upon the roughly filtered Marne water. The latter carries at times as many as 300 bacteria per c.c., and B. Coli is discoverable in 40 c.c. The color of the water is dull, with a brown to greenish hue. The water that comes from the sterilizer is bright and sparkling, and highly transparent. The perceptible odor at the sterilizer is almost entirely vanished before it is ready to flow away from the last compartment. There is no increase in nitrates in the ozonized water as compared with the filtered water, nor are there any nitrites, chlorine compounds, or any peroxide of hydrogen traceable to the electric discharge. These are the conclusions drawn by Drs. Ogier and Bonjean (1904) and by Dr. Rideal (1908)."

In some plants water contains over 4,000 bacteria per c.c. and is made safe with ozone treatment.

"In Ginnekin, Holland, the ozone treatment reverses the vitiated condition of the water, and produces an effluent which is not only to all intents sterile, but is clear, sparkling, and, to use the description of Professor Gerard, appetizing. It has acquired all the properties of the best upland water, which is only distinguishable to the chemist."

Some Representative Installations

Fig. 2 shows an installation which has been working for about six years at the Chicago, Burlington & Quincy Railroad 17-story office building, in Chicago. It is in the second basement of the building, in the power plant. The equipment consists of a switchboard, with two sets of ozone generators, consisting of ten tubes each. On the top of the switchboard there is a rotary converter direct to alternating current. At the bottom of the panel there is an air dryer and air pump. The air pump, which blows the air through the tubes into the ozone sterilizer water chamber, is shown in Fig. 3, on the top of the tank. The tank itself is white enameled inside and has refrigerating coils on the outside, and is well insulated to keep it cooled.

From this tank the water is piped throughout the building and circulated to every bubbling fountain for 2,500 employes and about 500 to 600 other people who come and go in the building. The capacity of this plant is about 800 gals. an hour. The water, before it comes to the sterilizer, goes through a sand filter, also a paper filter.

Fig. 4 shows a recent installation at the Phoenix Knitting Works, Milwaukee, Wis. Fig. 5 shows an installation for schools, public buildings, and bottlers of carbonated beverages. Flynn & Co., in Quincy, Ill., have had an outfit in use for five or six years, of about 700 gals. per hour capacity. Fig. 6 is a municipal or large industrial plant. Fig. 7 is for use in residences and small factories. The Chicago Box Company have used it successfully for years for their office and about 90 employes in their factory. There are over a hundred of these in Chicago alone. Besides municipal, industrial, hospital and residential outfits, there is a distinct feature that the Electric Ozone Sterilizer Company is in position to design and build: a special portable outfit for expeditions, contractors, builders, and for soldiers while in the barracks and in the field. The German army was equipped with portable outfits long before 1912, also the Russian army and Japanese army were equipped with them as far back as the Russian-Japanese war.

The space required for the apparatus is very small. Each tube has a capacity of 30 to 200 gals. of water per hour; its electric consumption is about 2 watts. It merely means a duplication and many sets of tubes and mixing chambers for a larger plant. The results are positive, without any question or doubt as to the outcome. The process has proved itself in the last decade. It not only disposes of the bacteria, but takes out the odor and improves the taste of drinking water, without leaving any residue or chemicals in the tap water, and hardly changing the mineral content of the water.

Some Points Worth Considering in the Design of Sewage Treatment Works

By John H. Gregory, Consulting Engineer, 170 Broadway, New York City

In recent years a large number of sewage treatment works have been built, but it can hardly be said that all of the works have been satisfactory when judged from the operating as well as from other standpoints. In some cases fundamental errors have been made in the type of works adopted, but such instances are probably relatively few. The failure, then, of the works to fulfill expectations may be due either to neglect in the design of what many would call the minor details, to appreciation on the part of the designer as to how the works will operate, or to inefficient operation.

In this brief article it is intended to draw attention to some of the points, but by no means all, which may well be considered in the design and construction of such works, and which have been brought home to the writer not only as the result of many years' experience in designing sewage treatment works of various types, but also as the result of having visited and inspected a large number of works in this country and abroad.

General Arrangement and Accessibility

Careful consideration of the general arrangement of the works is time well spent and the arrangement should be studied not only from the standpoint of efficiency, but also convenience of operation. While the two points just mentioned may be of greatest importance, nevertheless, it is highly desirable to consider the general appearance of the proposed works as they would be viewed not only by the professional engineer, but by the casual observer.

A compact arrangement of the several parts of the works is desirable, but if too compact the finished works will look crowded. There must be elbow room, not only for convenience of maintenance and operation, but also for the sake of appearance. Again, if too compact an arrangement is adopted, it may be more or less difficult to arrange for future extensions or connections. The tendency is to build works ample for the present and for a few years to come, but not to build works of size sufficient to serve for a long period of years. Practice in sewage treatment has changed and probably will change more or less from time to time and while a works when built may be thoroughly up to date it may not be so some years later. In other words, an extension of the plant may involve a somewhat different method of treatment of the sewage, either in whole or in part, and, therefore, it is desirable that the arrangement of the works be not too compact so as to permit of readily making connections to the works in the future at several points should occasion so demand.

Reference may now be made to some features more or less common to many treatment works as illustrating to a certain extent the point of view to which the writer wishes to call attention.

Grit Chambers

The function of a grit chamber, as the name may imply, is to remove grit, rather than organic matter, but we may well ask, have all of the grit chambers which have been built satisfactorily fulfilled the above requirement? If not, the velocity through the chamber may have been so high as to carry a very considerable portion of the grit through the chamber, or else it may have been so retarded as to cause an appreciable deposition of organic matter. It is possible to design a grit chamber which will operate satisfactorily, but it cannot be done by making one or two rough computations and assuming that the result thereby reached is good enough.

For example, not only must the present, but also the future rate of sewage flow be considered, as well as the hourly and daily variations in rate of flow. Another feature, which must be carefully considered, is the shape and section of the approach. It is obvious that the sewage should enter the chamber with as little eddy action as possible and without cross currents. A grit chamber is not a long structure and failure to provide a suitable approach may interfere very materially with its efficiency in operation.

If a grit chamber serves the purpose for which it is designed, grit will be deposited and must be removed from time to time as occasion demands. Such being the case, provision should be made, in designing the works, for easily removing the grit, and if in order to do this the chamber must be unwatered, means should be provided so that this can be quickly and easily done.

And after the grit has been removed from the chamber it must be disposed of somewhere. If it is inoffensive it can be readily used for filling, but if offensive it should be buried, or first washed if it is to be used for filling. It certainly does not want to be left lying around anywhere and everywhere at the works as is sometimes the case. Such a method of disposal would be likely to cause the visitor to go away with the idea, and perhaps rightly, that the works were carelessly operated.

Screens

Screens, in some form or other, are generally needed at a sewage treatment works, the fineness of the screens being dependent on the results desired, but if screens are used they must be cleaned and the screenings removed. The frequency of cleaning depends largely on the fineness of the screens, but also on the character of the sewage. Screening is generally the first step in the treatment of sewage at a works and is forever with the operator whenever the works are in operation. Too much thought cannot be given to screen design, not only from the standpoint of the removal of floating and suspended matter, but also from the standpoint of convenience of operation. This means that not only must the screen itself be so designed that it can be easily and readily cleaned, but also that the arrangement of the structure around the screen must be such that all parts of the screen are easily accessible to the operator, and a suitable platform or platforms must be provided from which he can work. Attention to small details here are vital, and yet how often have they been neglected or overlooked.

Screenings accumulate, not only daily, but hourly. With a very coarse screen they may be inoffensive, whereas with a finer screen they are likely to be offensive, and with a fine screen still more offensive. In other words, the finer the screen the greater the amount of screenings removed and the more offensive they become. Screenings containing much organic matter, especially that which is easily putrescible, *must* be removed and disposed of promptly or else a nuisance is almost sure to result. And yet the disposal of the screenings is often overlooked. It is not the intention to discuss here the means of disposing of the screenings, but the writer does desire to emphasize the necessity of prompt disposal, and by disposal he does not mean simply taking the screenings to a nearby point and there storing or dumping them.

The actual purification secured by screens, even fine screens, is small, very small, notwithstanding that the material removed, especially by fine screens, is very offensive and putrescible. And in considering whether or not to adopt fine screens the fact should by no means be overlooked that their adoption means the continual disposal above water of a small but extremely offensive material, and that the nuisance caused by an improperly operated fine screening plant may be put on a par with that caused by improperly operated sewage treatment works of other types.

Open Channels

Open channels in and about a sewage treatment works are, in general, preferable to covered conduits. They are much easier to clean and inspect. It is not always possible, however, to provide open channels, but when used they should be of substantial construction, not the flimsy construction which may be seen at times. It seems hardly necessary to say that self-cleansing velocities should be used, but many instances can be cited where this point has been entirely overlooked. If it becomes necessary, as sometimes is the case, to use low velocities, then the adoption of open channels is especially desirable, as they can be much more readily kept clean than can covered conduits.

Tool House

A tool house, or store house of some kind, even if small, is almost a necessity, and yet how often has it been omitted with works which have been built. In some works which the writer has visited it seems almost as if the fact that sewage was to go through the works had been entirely overlooked and that tools of one kind or another had to be used. A tool house is not an expensive luxury and is always appreciated by the operator. It may be that but few tools will be required and that but very simple records of operation must be kept, but if a tool house is provided a place is then available for the putting away of tools, as well as small stores and supplies and for the keeping of records.

Closure

In the foregoing perhaps enough has been said to call attention to the necessity of giving careful consideration to all of the details of a sewage treatment works, and especially to what some might call the minor details. It is often that attention given to just these minor details will be the difference between success and failure.

In studying the design of a sewage treatment works, and especially convenience of operation, one cannot do better than to place himself in the position of the operator and study the design from the standpoint of the operator, commencing at the point where the sewage enters the works and ending with the disposition of the effluent as well as that of all of the material removed in the various steps of the process. If this will only be done, before a design is completed and the works built, much good may result from such a study.

In closing, attention should be called to one other point, and in the opinion of the writer a most important one, namely the aesthetic treatment of the works. And yet how little attention, especially in this country, has been paid to this phase of the subject. It doesn't cost much more to trim up the exposed parts of the structures in a neat manner than to omit such trimming. The tops of walls can be finished with copings at a very slight increased expense, with the result that the structures have a finished appearance, and yet how many instances can be cited where walls have not been so treated and have been left with ragged and chipped edges and out of line.

Again, it doesn't cost very much to provide gravel walks around a works, especially so that all operating points are readily accessible. And yet, have such walks generally been provided?

Still further, it doesn't cost much to provide a little planting and flowering shrubs and hedges. And yet, how often are they to be seen at a sewage treatment works?

Is is not worth while to pay more attention to some of the points considered herein as well as to others of a similar nature?

DRAINAGE AND IRRIGATION

The Outlook for Land Drainage for the Year 1918

By A. H. Beitman, of Edmund T. Perkins Co., 317 Illinois State Bank Bldg., Quincy, Ill.

With the growing demand for food, the question of producing, from every acre of tillable land, the greatest possible crop has become a necessity. Scientific farming is daily assuming greater importance, but as yet drainage, a fundamental requirement, has not received the attention which it merits. In fact, construction work on drainage projects has been retarded for lack of equipment, material, supplies and labor, and unless those in charge of drainage projects bestir themselves to obtain the desired assistance from the Federal government, the outlook for drainage for 1918, and probably for the next ten years after the war will be dismal.

Public Sentiment Must Be Aroused

The drainage situation is in fact very alarming. The several bureaus of the Federal government, overburdened with other work, have little time to investigate industries which are not immediately concerned with war activities, and it is only by proper presentation of the facts that an industry which is an essential factor in food production will receive assistance. No one is better qualified to know these facts than those engineers who have failed to obtain priority rights from the Priorities Division of the War Industries Board, or been unable to obtain from the capital issues committee authority for needed bond issues. The public at large has not realized the importance of drainage as a requirement for greater food production, nor as an economic factor in the development of the country, and unless public sentiment is aroused and made to see its importance, the desired results will not be forthcoming.

Extent of Unproductive Land

According to the 1910 census there were 478,000,000 acres of improved lands in farms in the United States. The Department of Agriculture has estimated that of this area, approximately 150,000,000 acres are producing only 20% as much as they should on account of insufficient drainage. In addition to this area there are in the United States about 80,000,000 acres of swamp and overflowed land at present unproductive, unhealthy and a menace to the people of the United States.

With a small expenditure of money and time, a large part of this land could be reclaimed and made a garden spot.

Progress of Reclamation of Waste Lands

Thus millions of acres in this country are curtailed in their productiveness on account of surplus water and frequent floods throughout the growing season. The progress that is being made to reclaim these waste areas is very unsatisfactory. A request for information as to the present status of the work and its effect upon the present situation was sent out recently in the following form:

TABLE I

Report

Cypress Creek Drainage District, Desha and Chicot Counties, State of Arkansas. S. W. Whitthorne, engineer.

Commissioners: Dr. Vernon MacCammon, Arkansas City, Ark.; Gus Waterman, Dumas, Ark.; T. D. Newton, Sr., Winchester, Ark.; E. G. Newlin. Watson, Ark.; Ed Warrington, McArthur, Ark. Office address. Arkansas City, Ark.

No.	Question	Answer
1.	Acres in district?	289,000
2.	Approximate acres in cultivation?	31,000
3.	Crops jeopardized in 1918 if improvement stops?	26,500
4.	Acres to be in cultivation in 1918?	33,000
5.	Probable number of acres to be in cultivation in 1919?	38,000
6.	Total cost of reclamation?	$1,000,000
7.	Per cent completed?	42%
8.	When will work be finished?	Dec., 1919
9.	*Coal necessary for the completion of this work?	6,000 tons
10.	Wire rope necessary for the completion of work (rope given equivalent to 1-in. W. R.)	40,000 ft.
11.	Amount of repairs (iron and steel castings, structural and bar steel, cast and sheet brass, pipe and fittings)?	$21,000
12.	Number of skilled laborers required to operate the machines on this work?	30 men
13.	†Number of unskilled?	35 men
14.	Number of men who are in Class 1 of the draft?	2 men
15.	Amount of oil needed to finish this work?	300 bbls.
16.	Average corn crop per acre?	35 bu.
17.	Average cotton crop per acre?	235 lbs.

*Only one plant out of five is using coal. Balance use wood cut off of right of way.

†About 30 additional colored hands are used in cutting wood and clearing right of way, when not engaged as farm hands on local plantations.

Conditions in 87 Important Drainage Districts

Replies were received from 87 drainage districts, showing the results given in Table II.

TABLE II

States	No. of D. D.	Acres	Cost	Acres Cultivated In 1918	Acres Cultivated In 1919
Arkansas	17	991,000	$5,860,000	328,000	449,000
Florida	3	217,000	325,000	1,000	3,000
Illinois	6	163,000	8,294,000	54,000	78,000
Indiana	3	1,003,000	374,000	48,000	144,000
Iowa	20	587,000	5,220,000	342,000	417,000
Kentucky	1	55,000	624,000	41,000	50,000
Louisiana	1	3,000	100,000	2,000	3,000
Minnesota	4	963,000	589,000	22,000	66,000
Missouri	13	769,000	8,383,000	401,000	554,000
Mississippi	6	185,000	1,156,000	71,000	146,000
Nebraska	2	7,000	76,000	5,000	6,000
Tennessee	10	135,000	1,135,000	35,000	59,000
Wisconsin	1	2,000	10,000	1,000	2,000
South Atl'tic states.		52,000	650,000	18,000	22,000
Total	87	5,132,000	$32,796,000	1,369,000	1,999,000

Rate of Reclamation of Swamp Land

This shows that the progress of reclamation of swamp and overflowed land is at the rate of about 1,590,000 acres per year, and at that rate it will take 53 years to reclaim all swamp and overflowed lands in the United States. The progress in tiling farms is still slower and, according to reliable estimates, it will take 180 years at the present rate of progress to make 100% productive the 150,000,000 acres of tillable land, which are producing now only 20% as much as they should on account of insufficient drainage.

According to the 1910 census, the tillable area per person in the United States was 53 acres. Should we maintain this ratio it would mean that with an increase of 2,000,000 population per year the tillable area in the United States should increase at the rate of 106,000,000 acres per year. It is true that a much smaller area than 53 acres will be capable of sustaining a person, but, notwithstanding, with the increase in population, it becomes necessary that we also increase considerably the productiveness of every acre, and especially the tillable area in the United States unless we would find ourselves in years of small crop production in the same situation as we are now.

Existing Conditions in Detail

Since drainage is primarily an engineering problem, it behooves every engineer to take a stand with definite and distinct demands for the protection of this great industry by the

various departments at Washington, and arrange for a continued active watching and safeguarding of their interests and the public. In detail the following are the existing conditions:

(1) Finance—To finance drainage work it will be necessary to submit proposed issues of bonds to the Capital Issues Committee. The application will be referred by this committee to the Bureau of Drainage Investigations for recommendation and only those projects which are in a large percentage completed or which promise immediate results will be approved, as immediate food production for the war is the deciding factor.

(2) Fuel—The Fuel Administration is positive in the statement that the crisis in supplying fuel is past. When a drainage district cannot get the fuel for the contractor or for the pumping station furnished by local coal dealers, they can submit their contract to the Fuel Administration to the Department of Apportionment and Distribution, Domestic Industries, Washington, D. C., with the approval of the Department of Agriculture as to the necessity of material and assistance will be rendered in obtaining the necessary fuel.

(3) Transportation—With the approval of the Department of Agriculture, the Car Service Bureau, 1019 Interstate Commerce Building, Washington, D. C., will undertake to provide necessary cars, but this bureau takes the same positive stand as the Fuel Administration and insists that the crisis is now past and that there will be no difficulty in obtaining cars.

(4) Priority Certificates—The priority committee will issue priority rights if the request has endorsement of the Department of Agriculture. The Priority Division is also conducting through its Bureau of Investigation and Research, an investigation as to why the priority is requested and the necessity for it must be shown by establishing the fact as to how much sooner delivery will be made with the priority certificate than in the ordinary course of business. Then the fact having been established that a priority certificate is necessary and helpful, it will be issued.

How to Protect the Industry

It is, therefore, seen that for the protection of the industry, it is necessary to impress upon the Department of Agriculture the necessity of prompt and favorable decision, and aid this department in obtaining the necessary field force to make prompt investigations and reports. It is impossible for the engineer alone to obtain relief from the situation and he must present this matter to the taxpayer and officials of drainage projects so that they may join in the effort.

WATER WORKS MAINTENANCE AND OPERATION

Watering and Un-Watering an Industrial Plant and Its Relation to the Public Water Supply

By Wm. F. Wilcox, Superintendent Central Water Works, Tennessee Coal, Iron and Railroad Co., Ensley, Ala.

The only point on which there is a fundamental difference between an industrial and a public water supply is the question of political expediency, from which the industrial operations are happily free.

Magnitude of the Problem

As large industrial plants spread their various operations, the question of watering the manufacturing and un-watering the mining operations becomes a problem involving the expenditure of millions of dollars and much care and thought. It may be surprising to many to know that there are few cities, and practically no towns, that could handle the water supply of a reasonably large industrial operation. The requirements of industrial water plants, the oftentimes unusual conditions, and the character of many of the problems, varying in capacity, pressure and volume, make each installation a separate study. The designing engineer is called upon to consider the wide needs lying between the supply for a small town of, say, one hundred inhabitants, to the equivalent of a city of half a million population.

Diverse Nature of the Problem

We have the question of wells for some supplies; for others the use of water from streams, rivers and lakes, with the conditions varying from that of a town or city in comparatively flat territory to those of a town or city in mountainous country. Sometimes the question of drainage may be paramount in a mining operation, and sometimes the requirement of a manufacturing plant, with its large volume, and if circumstances favor a low head the conditions may approach those of a mechanically operated drainage system. In other manufacturing plants the problem may assume the general character of a large city pumping against a reasonably high head. It may, therefore, be seen that the industrial water supply problem is very varied and may be compared to the conditions which will be met by a consulting engineer whose services are rendered to a large and widely distributed clientele.

Six Grand Divisions of Industrial Water Supply

An industrial supply may, for convenience, be classified under six general heads:

(1) An abundance of pure, wholesome water for drinking and bathing purposes. (2) An adequate and satisfactory boiler water supply. (3) A constant and ample supply for condensing and cooling purposes. (4) The un-watering of mining operations and the disposal of the output. (5) Pumping, treatment and disposal of plant wastes. (6) Water under heavy pressure for hydraulic operations.

The first classification is naturally paramount, and in this day of liberal management on the part of large corporations it is given the closest scrutiny. With the present high development of the science of water treatment, this question may usually be solved even more readily than the third classification. But the first and second classifications are intimately related, assuming that an industrial operation has an ample supply of water; this supply must be further capable of yielding water under the first and second classifications, or sufficiently near some source which can be drawn upon for water meeting these requirements.

The several classifications will now be considered in more or less detail and under their proper headings, with a view to understanding more thoroughly what may be called the six grand divisions of industrial water supply.

Water for Drinking and Bathing Purposes

Considering the operation as a whole, we may assume that we are called upon to supply water to from 20 to 30 sub-departments of the operation, varying in their requirements from those of a village of 500 people to a small city of 25,000.

The health, happiness and general welfare of the employes of a modern plant are of prime importance. The best possible sanitary conditions, coupled with proper provision for the

housing of the employes, is one of the largest assets which a corporation may hope to have. Therefore, where local conditions do not meet these requirements, they must be maintained by the corporation. To this end many corporations have been compelled to expend large sums of money in the establishment of the most modern type of village and town, with adequate and proper water supply.

When these conditions are recognized and met it results in a healthy, happy and loyal set of operatives and a prosperous industrial organization. After providing a proper water supply, intelligent and careful scrutiny must be made of the water, and examinations, both sanitary and bacteriological, must be constantly made, and every effort put forth to insure an ample, pure and wholesome water supply for drinking and bathing purposes. And it must be impressed that drinking and bathing are the two essentials of what may be termed the domestic water supply department of an industrial organization.

Oftentimes the local public water supply is capable and willing and does meet the requirements of the several operations. In some other instances it may be desirable for the industrial operation to provide its own domestic water supply. Whatever may be the conclusion as to the source of this water supply, it must be remembered that every day the health departments of the corporations are constantly in touch with and carefully watching to see that this water is of the highest standard.

In mining towns, and sometimes in industrial plants, the water supply may be operated under the same general conditions as those governing the water supply of a village or town, and sometimes of a small city. If this should be the case, of course we would meet the identical problems as if called upon to design a water supply for a similarly sized community.

Keeping before us the prime essentials of a water supply, its purity, abundance and suitable volume and pressure for domestic and fire-fighting purposes, in some instances we must go further and provide for the softening or treatment of the water, should the best available source not meet the highest requirements of the present-day sanitary engineer.

Boiler Water Supply

The boiler water supply may vary in the many operations from a few thousand gallons per day, which may be taken from the domestic supply, to possibly 4,000,000 or 5,000,000 gals. per day, which may be required for the boilers of a reasonably large industrial plant.

In the smaller operations the boiler water supply may be dismissed as an instance. In the larger operations, after the boiler plants have begun to assume the output of 1,000 or even 50,000 horse-power hours, the boiler water becomes quite a question. We must consider the quality of the supply and its cost of delivery in more detail than we would for a smaller plant. The quality is the most important factor, for the boiler plant is necessarily the heart of any steam-operated industrial organization. It is not unusual to find filtration and softening plants handling 4,000,000 to 5,000,000 gals. of water per day, it having been found more desirable to filter and soften water, where desirable or necessary, rather than attempt treatment by boiler compounds, this being true especially of the larger plants.

It has often been found desirable to use water which has previously done work in cooling and heating, as many advantages may be obtained thereby. In this way we not only receive the benefit of the reclamation of the otherwise wasted heat units, but also materially reduce the cost of boiler repairs. In the larger industrial plants the boiler water supply, through this cycle of usage, may more than pay for the cost of its improvement, and usually does, when we consider the efficiency of the boiler plant, saving of time required for repairs, economy of operation and increased plant rating.

The water from mining operations sometimes carries in suspension free acid; the plants being small, if there is no available waste heat, these plants usually draw their water from the domestic supply as the most desirable and economical source.

Water for Condensing and Cooling Purposes

This is necessarily the largest operation of an industrial water supply, and causes the expenditure of more money per annum than the other five of the main subdivisions combined, and also yields the largest profit. It would be difficult efficiently to conduct any large industrial operation with steam power without a constant and ample supply of cooling and condensing water. It is more than probable that such a supply of water, even when compared with a reasonable and necessary amount, would make the difference between a successful and profitable enterprise and an unsuccessful one.

It therefore may be readily seen that such an important item as this supply becomes in the present modern industrial plant, when one considers its effect upon mechanical efficiency, a prominent question in determining the location of this class of enterprise. Some of the larger plants of this country have found it necessary to move from the ore and coal fields to the water supply. Some plants have unusually favorable conditions, both as to accessibility of their raw material and the availability of a suitable water source. In other localities the plants have been able to solve their condensing water supply difficulties by the installation of cooling towers and spray ponds or the construction of expensive reservoirs and impounding systems, and are now in successful operation. In plants of the character of blast furnaces, it is found that approximately 10,000 gals. of "make-up" water must be supplied for each ton of production, and to this amount may be added from once to twice as much rehandled water. Water is now rehandled through this class of plants for several reasons, and it is dependent, first, upon the temperature of the water, and second, upon the character of the operation, with its more or less elaborate and efficient systems of cooling and condensing. It is desirable, where possible, to use the fresh "make-up" water through the condensing apparata of such units as blowing engines and electrical generators, as the cooler water produces a more satisfactory and higher vacuum, and improves the cycle of efficiency.

After the water has passed the condensers it is generally rehandled with low-head pumps, sometimes with and sometimes without the addition of cooler water, directly to the cooling equipment of the blast furnaces proper. From quite a number of these uses sufficient water of proper quality may be reclaimed at a temperature of approximately 120 deg. Fahr., and from there carried to the water-softening plants for boiler purposes. In some plants the water may be further used for such valuable purposes as the granulation of slag; this is becoming quite a saving since cement plants have begun to utilize this previous source of waste, and in cases where the slag has not been a waste this utilization may increase what may have been only a nominal profit into a satisfactory one.

If the industrial plant shall be of the character of a steel plant, manufacturing finished products, the ultimate consumption of water may reach 20,000 to 25,000 gals. per ton of finished product, and even in these further operations it is necessary to rehandle from an equal to a double amount of water before it is finally turned away. Properly constructed and operated modern plants, which take their water to the best advantage, have been able to reduce materially their cost of operation by the reduction of the amount of steam used and the increase in the length of life of those parts of the operation which are usually subjected to a very high heat.

With the realization of the advantage of ample supplies of cooling and condensing water, it is now becoming a rarity to see large non-condensing engines. Even in that class of operations which require the use of non-condensing engines we are able to take this exhaust steam into a receiver and thence

to low or mixed-pressure turbines, which are today in many plants generating thousands of kilowatts of electricity from what was previously waste heat and energy.

The installations for plants handling the primary water supply are necessarily varied. In the larger plants it is not unusual to find three classes of engines, with individual units capable of handling 30,000,000 gals. per day each, and boiler plants, stoker-fired, and equipped with superheaters and all of the latest heat-saving devices.

The larger units in the primary plants are, first, the reciprocating engines, either triple-expansion or cross-compound, condensing engines, varying from 125,000,000 ft.-lbs. duty for units of the 5,000,000-gal. capacity to 200,000,000 ft.-lbs. for 30,000,000-gal. triple-expansion. Some of the most interesting units are the cross-compound condensing engines of 12,000,000 to 15,000,000-gal. capacity, which have developed as high as 165,000,000 ft.-lbs. duty when operating with 150 lbs. steam and 50 degrees superheat.

A second class is the centrifugal pump in the later and larger sizes, driven by steam turbines, with as many as 14 stages, and which, running under 28 ins. of vacuum, give as high as 135,000,000 ft.-lbs. duty.

The electrically-driven centrifugal unit is a very useful one, and the selection of the motor depends upon the characteristics of the load of the industrial operation, as to whether or not the motor shall be synchronous or of the induction type.

It is desirable, in a plant putting out from 40,000,000 to 50,000,000 gals. per day, to have two 30,000,000-gal. units and two 15,000,000-gal. units. This gives a very flexible and dependable installation, and allows the operation of the units up to their best capacity and economy.

In some localities most of the plants have demanded installation of additional supplies. Under these conditions it is not unusual to find that the new station is of the highest type of engine and boiler equipment and operates under practically 100 per cent. load, the older station being held as a reserve. One particular instance is in mind where for five years the new station operated under a load of 100 per cent. average, by Venturi meter, and the older or abandoned station was held as a reserve. When this class of installation is encountered, marked difference is shown between the well-designed, efficiently operated station, with a high-load factor, and the old station, which is generally apt to be a succession of additions, and to contain machines which are inefficient from a present-day standpoint, but reliable and valuable when held as reserves.

In the rehandling water problem it has been found that the head is largely the controlling factor of the unit capacity for such uses as condenser circulation and mechanical cooling. This class of machinery is more or less varied in use and condition, and the principal choices on sizes of 5,000,000 gals. per day are the crank and flywheel reciprocating and the centrifugal pump, either electrically or steam-driven, the final selection being largely governed by the permanence of the operation, available space and proper operating head.

It is impossible to lay down any general rule of selection. The installation must necessarily be governed by the solution of the particular problem in hand.

After an examination of the above general outline it may readily be seen that where these many uses are carefully considered and worked out so as to balance properly, the large industrial plants are wise in the expenditure of large sums of money to provide the necessary water for this class of uses.

In laying out a system having in mind these particular uses, one would be largely governed by the same reasons that would apply in designing a fire protection for a large city. The volume of water to be provided for must be carefully worked out and careful consideration given to the factor of safety, and considerable thought should be given to the question of future demand. For as the improved equipment shall be discovered or produced, the use of water will be increased whenever the economy of any operation may be materially improved.

The pressures for each requirement of the several operations must be thoughtfully considered, for each operation must have that pressure which will give the most desired efficiency in daily operation. The reliability of the supply is possibly the greatest single point on which the operating management judges the efficiency of the water supply division.

Unwatering Mining Operations

In mining operations provision must be made for taking care of the infiltration of water through the seams, fissures and faults. Some of the mining operations are very deep, being as much as 5,000 ft. below the surface of the ground. Some of them, although extending 3 or 4 miles back under the ground, are comparatively shallow and may be easily unwatered through bore-holes. As a general rule, the amount of water to be contended with is largely controlled by surface conditions, which are, of course, dependent upon the season of the year and the rainfall.

In some instances mining operations are in broken or faulty ground, and provision must be made for heavy inflows of water during flood periods. The types of pumps which are most generally in use now are electrically driven and may be of the triplex-geared displacement design or else of the centrifugal type. These two types have each their particular advantages and are used at the option and judgment of the engineer.

Nearly always the cost of unwatering a mine is an expense chargeable against the operating or mining costs. Wherever it is possible, the water from the mines is utilized largely, for two purposes: where free of contamination, the water is desirable for the drinking supply. The most general use, however, is for cooling purposes on such operations as require very low temperatures, it having been found that on operations similar to the by-products distillation plants, the cost of unwatering a group of near-by mines may be absorbed by utilizing this water in increasing the products of distillation. For as a general rule the mine waters run about 18 deg. C. as against 28 deg. to 30 deg. for surface water during the summer months.

Disposal of Plant Wastes

The problem of the disposal of plant wastes is looming up larger and larger every year. The increasing number of industrial plants and the widely varying and ever-increasing character of the run-off from these plants are now the subject of much thought.

It is very noticeable around Pittsburgh that surface waters are heavily charged, and the analyses of the water at McKeesport, as shown in the water plant of that city, indicate to one interested a large and varying quantity, as well as changing substances, of the chemicals carried in solution.

Many of these plant wastes are capable of dilution, so that they become harmless. Sometimes it is possible to neutralize alkaline water by combining it with some other waste which is acid, and vice versa. For one of these latter purposes pipe lines have been laid from eight to ten miles, in order to neutralize the wastes and protect adjacent property.

The policy of "live and let live" among the manufacturers and the laws governing the riparian rights make it very desirable that the plant wastes be carefully watched. Where two or more plants are located upon the same stream, the water may be used several times before passing the plant farthest down stream. It is, therefore, not unusual to note that many devices are being installed to cool, treat and clarify the wastes from each plant, so that the rights of each and every one may be protected, and the individual efficiencies held at the highest point.

In addition to this, nearly all wastes are valuable, if of sufficient quantity, and therefore the cycle of efficiency ever tends

to reduce the careless distribution of deleterious substances which have heretofore been thrown into the streams.

Heavy Pressure for Hydraulic Operations

The amount of water used for these purposes is not very large, but as a rule the machinery is very heavy and the cost of installation very large. For the present, direct-acting pumps are largely used, but a few of the newer installations have centrifugal pumps. The pressures range from 550 to 800 lbs.

The principal uses for this class of water are the operating of tilting furnaces carrying as much as 100 tons of molten metal; manipulators for handling and turning ingots, opening and closing large gas valves; the operation of elevators carrying hot metal or explosives, and which demand steady, safe operation; the operation of heavy shears and punches, wheel presses, testing machinery and other similar apparata which require heavy power and slow operation.

In the operation of this class of machinery it is necessary to see that the water is filtered and of good quality, so as to keep down repairs due to erosion and corrosion.

General Summary

As usually outlined, the general scope of industrial water supply may be divided into few heads. These major divisions of operation are each many times subdivided. The investments for the several operations vary from a few hundreds of dollars to hundreds of thousands of dollars.

An engineer would at times be impressed by the high class of the installation, with its complete, labor-saving devices, with their attendant economies. On the other hand, one would feel inclined to wonder at some very inefficient operation, did he not know that the operation was temporary, or perhaps a break-down emergency. The general scope of the work and the multitudinous difficulties and differences make a very interesting and instructive study. In no class of practice would one be more impressed with the opportunity and value of the water works engineer. In this field the engineer has possibly the largest opportunity for intelligent design and selection, and the experience and ability of the engineer and his value to the organization may be easily determined by a careful study of the various operations designed and installed.

The problems coming under the head of industrial water supply are many, but they are being very carefully worked out, and the industrial plants are doing their part to protect all interested parties.

FROM WORKERS IN FIELD AND OFFICE

Attack on Chicago Creosote Oil Specification Fails

Editor of MUNICIPAL ENGINEERING:

Sir—Prior to 1912 the city of Chicago suffered from the same type of unfortunate experience as many other cities in connection with creosoted wood block pavements.

The use in wood paving blocks of creosote oils, which were adulterated with coal tar and water-gas tar, or which had been stripped of certain valuable elements, resulted in the expansion and bulging of blocks, the distortion of curb line, sticky, tar-covered streets in summer and slippery pavements in winter.

The trouble was so general and so serious that the city officials were constantly flooded with complaints from property owners and civic bodies. It soon became a question of either securing a cresote oil that would overcome these troubles or of abandoning the use of wood block pavement.

In 1912 the city discovered that a creosote oil of certain properties would give satisfactory results and the present Chicago Specifications—known the country over—were adopted. Since the adoption of these specifications, the city has had good service from its wood block pavements.

The Chicago Specifications

In brief, the Chicago Specifications provide that creosote oil to be acceptable for treating wood paving blocks must be of certain definite quality and must meet certain tests, of which the following are the more important:

A—When distilled, not more than 22% of the oil shall distill below 235 degrees C. and not more than 40% shall distill below 315 degrees C.—thus preventing the use of an oil containing volatile elements which soon leave the wood.

B—When distilled under certain specified condition, that part of the oil which distills between 250 degrees C. and 315 degrees C. must contain not less than 5% of tar acids—thus protecting the city against the use of creosote oil which has been stripped of its valuable acids or which has been adulterated with petroleum products.

C—The amount of unsaponifiable oil in the distillate coming over between 250 and 315 degrees C. must not exceed 1½% of this distillate—a further means of preventing adulteration with water-gas or petroleum products.

D—When distilled up to 355 degrees C. the residue must be waxy instead of brittle, and, when placed on white filter paper and warmed, the resulting oil spot must show a clear amber color. If this spot appears dark or black it shows adulteration with coal tar.

So successful have these specifications been in shutting out the use of adulterated or stripped oils that recently certain parties brought suit to enjoin the city of Chicago from enforcing its specifications.

These parties alleged that the specifications were both unfair and unnecessary; that it was impossible to produce a pure creosote oil of the above specifications, which would contain a minimum of 5% tar acids in the fraction stated, without infringing a patent owned by P. C. Reilly.

The decision of the court is of great importance to the creosoted wood paving block industry and to all city officials and engineers interested in this subject.

After a trial extending over nearly six days, the court decided that the specifications were just and fair; that the city was entirely within its rights in using specifications that would insure a pure cresote oil of the desired quality, and that there was not only an ample supply of tar from which such oil could be distilled, but, further, that any creosote oil manufacturer should be able to manufacture such an oil if willing to do so, as it in no way conflicted with the aforesaid Reilly patent.

It has proven that the Chicago oil could be produced at a temperature below 700 degrees F., while the Reilly patent covers products that are produced above that temperature only.

The Chicago Specifications have given Chicago perfect protection against bulging, bleeding and breaking down of creosoted wood block pavements. This so-called Chicago oil represents the minimum of quality that will insure perfect results in wood blocks.

Very truly yours,

Chicago, Ill. J. A. MEYER.

American Built Military Roads in France Will Endure

Editor MUNICIPAL ENGINEERING:

Sir—When the history of this war has been written the vital part good roads have played in the great struggle will be more fully realized than at present. At the start motor trucks leaped to the front as the modern pacemaker of flexible transportation, and ever-increasing war needs have demanded new roads and better roads as most necessary for the proper backing up of fighting forces.

Motor trucks by the thousands will contribute an enormous advantage to U. S. road engineers engaged in new construction back of our lines. It is estimated that 1,200 miles of highways will be built in 1918 by American road engineers in the rear of the firing line in France. To the special road building battalions is delegated the important task of keeping lines of communication constantly open, and Mack trucks working in conjunction with modern American road machinery will help to build new strategic lines and keep communicating roads in constant repair. The Mack fleet will be composed of several thousand dump trucks, hot road oilers, pressure sprinklers for making water-bound macadam, gasoline tank trucks, printing press trucks for printing blue prints, instructions, plans, reports, etc., machine shop trucks, blacksmith and tool repairing trucks.

Although France is particularly well endowed with good roads, it is often necessary for military reasons to construct many new lines. An estimate places the present mileage of French roads at 1 mile of road for each 1½ square miles of ground surface. The tremendous task of keeping these roads in perfect condition and building new ones at the same time can well be imagined when it is realized that so far as wear and tear are concerned war traffic is ten times as great as that on Fifth avenue, New York.

Most of the roads of France are built of water-bound macadam. The peculiar nature of the French soil, which is of limestone formation, lends itself readily to compaction under the road roller and makes a very good road building material, although it requires constant maintenance. The British, however, introduced the tarred surface road, and an increasing mileage of that type is found back of the British lines. One of the principal objections to the water-bound macadam road near the front is the dust which rises from it in dry weather under heavy war traffic. Clouds of dust draw artillery fire from the enemy, and for this reason U. S. engineers, in planning road construction and maintenance near the American front, will probably utilize large quantities of tar coating which is freely obtainable in France.

Of course the pressing object of American road construction is to provide for the immediate needs of our forces, but the work carries with it both utilitarian and historic value.

TYPE OF MACK MOTOR TRUCK USED BY U. S. ROAD BUILDING BATTALIONS IN FRANCE.

American system and modern methods promise to contribute many enduring benefits to France. Our road building battalions are going about their work scientifically. All is not destruction that comes out of war, and many American-built highways will remain to become of immeasurable value to France in conducting her commercial and social intercourse.

Very truly yours,

D. O. SKINNER,
International Motor Co.

New York City.

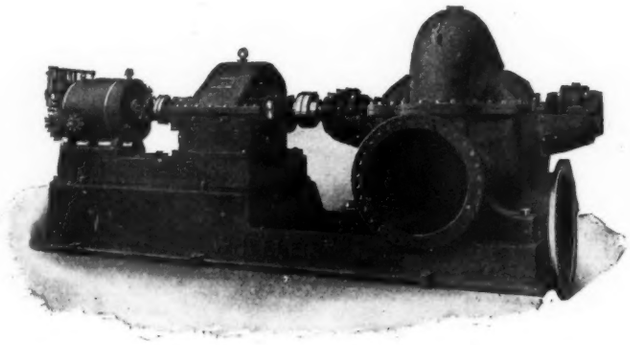
PLANT UNITS AND LAY OUTS

New Feature in Centrifugal Pump Design

Illustrated herewith is a new design of pump manufactured by the Wheeler Condenser and Engineering Company, that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this position it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep, etc.

This arrangement makes it possible to place a pumping unit in a room of small ground area—considerably smaller than where the suction end is opposite the outlet end, as is the most common practice. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gals.

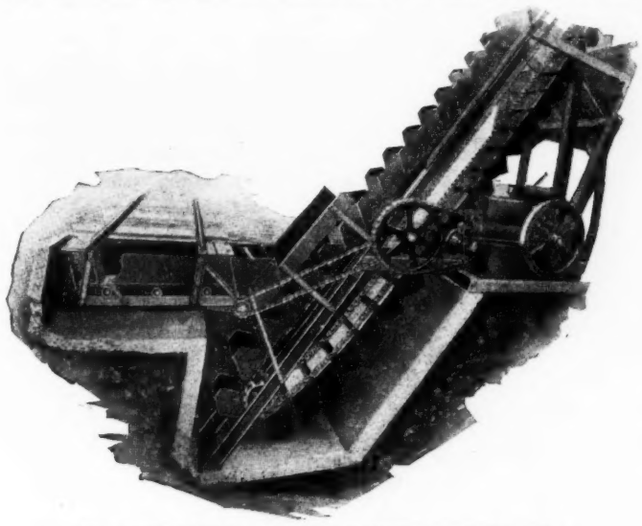


CENTRIFUGAL PUMP WITH SUCTION OPENING BENEATH AND PARALLEL TO END BEARING.

per minute against a head of 20 ft. The diameter of the outlet pipe is 36 ins. The speed of the pump is 240 r.p.m. and is coupled by a 10-to-1 reduction gear to a steam turbine whose speed is 2,400 r.p.m.

Automatic Car Loader and Unloader

The "Columbus" automatic car unloader consists of an all-steel reciprocating feeder placed between the ties and parallel with them, and a steel bucket elevator attached. For power, gas, oil, steam or electric current may be employed. The material elevated can be discharged into a bin, a conveyor, or disposed of otherwise as desired.



AN AUTOMATIC CAR UNLOADER DRIVEN BY A 7½-H. P. OIL ENGINE.

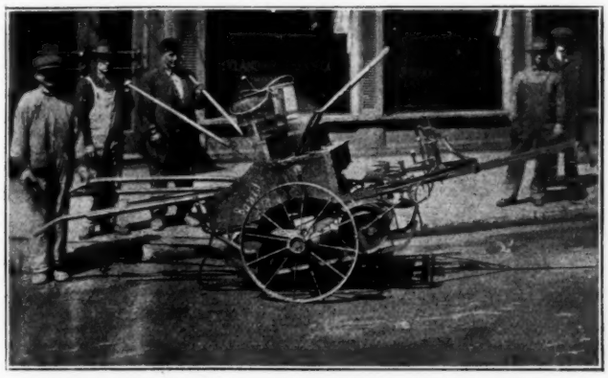
By reversing the position of the feeder and elevator, cars can be loaded quickly with this device. The loader and unloader are made to suit the size of the material to be handled, in the capacity desired.

The feeder consists of a rectangular box, with steel sides and bottom, carried back and forth on flange roller bearings running on a steel under-frame. A crankshaft joined to the feeder by a connecting rod drives it back and forth. The forward movement of the feeder carries the load to the elevator, delivering part of it into the bucket on the return stroke, while the load in it is prevented from returning by a stationary back plate located inside and at the rear end. The elevator is of the continuous bucket type, provided with a take-up for the adjustment of bucket chains. A typical "Columbus" automatic car loader, driven by a 7½-h.p. oil engine is here illustrated. It is claimed this equipment will handle from six to eight cars of coal per day with but a single operator.

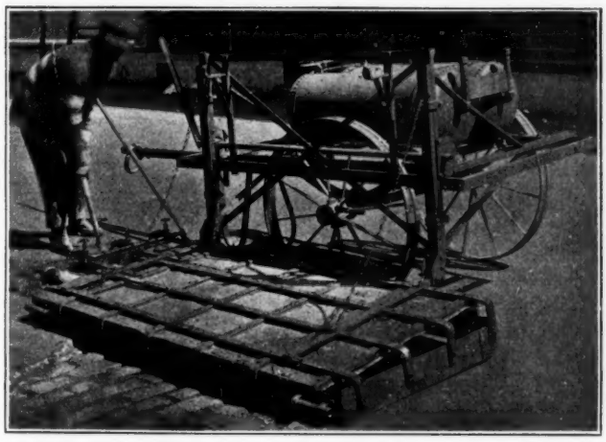
New Machine Successfully Employed in Repairing Asphalt Streets

In heating the tools used in making repairs to asphalt street pavements, heaters of the old type often made so much smoke that they were considered a public nuisance. Complaints on this score have been common in both residential and business districts, in the former from housekeepers and in the latter from business men. This cause has operated to reduce somewhat the popularity of asphalt streets, which are easy to repair and which should be repaired quickly without nuisance or inconvenience to owners of property abutting on the street. The tool heater of the old type not only emitted dense clouds of black smoke, comparable to a "smoky factory chimney," in the words of an experienced asphalt foreman employed by a big city, but its bulk obstructed the street and its inefficiency kept it standing long in the same place.

One of the pictures shown herewith illustrates a new type of asphalt tool heater that not only heats tools quickly and keeps them hot, but eliminates entirely the smoke and fumes produced by the older types of tool heaters. This new heater also eliminates the carting of wood, coal and coke for fuel purposes and no ashes are produced. This machine operates on kerosene fuel. The view shows the machine in successful operation on the principal boulevard of one of the largest cities in the country. The small amount of space occupied by the heater, adjacent to the curb, will be noted. Although operating in full blast it will be seen from the picture that the machine was not giving off any smoke and it did not emit fumes.



VIEW OF "PHISTO" KEROSENE ASPHALT TOOL IN OPERATION.



VIEW OF "PLUTO" ASPHALT SURFACE HEATER IN HEATER IN OPERATION.

In operation this kerosene tool heater requires but little attention from one man. While the tools are kept hot they are not burned. The work of street repair is speeded up because the men have hot tools all the time. The available truck and team capacity is used entirely for transporting the materials used in making repairs and not at all for hauling wood and coal to the heater and ashes away from it. Experience indicates that 25 gals. of kerosene will run this heater at full capacity for 10 hours continuous operation. These Phisto Kerosene Tool Heaters, distributed by the Alger Supply Co. of Chicago, are proving successful wherever used. They are in service in a number of the larger cities. On a consumption of 3 gals. of kerosene per hour the furnace will keep constantly hot 14 tools, 3 pails of binder and 3 scoop shovels.

The other illustration shows the Pluto Asphalt Surface Heater, distributed by the same company. It will heat 36 sq. ft. of sheet asphalt surface to a proper consistency for handling in from 5 to 7 minutes. It saves both teaming and materials.

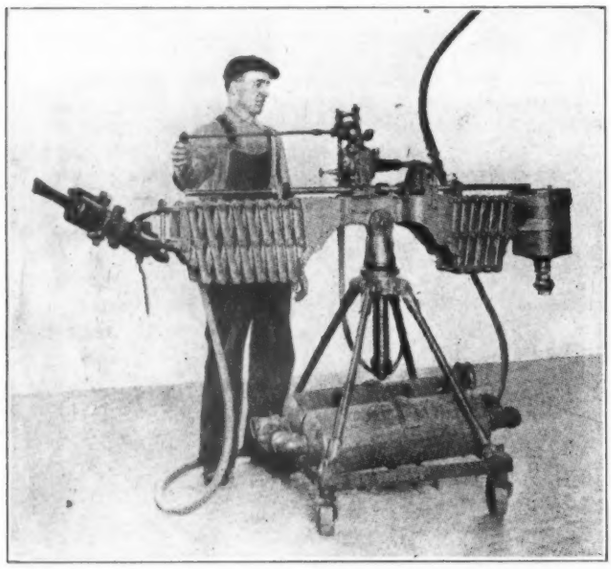
It can be operated by one man and the fuel required is 6 gals. of kerosene per hour.

In the illustration the surface heater is shown driving the moisture off the old granite block underlying the sheet asphalt surfacing so that the paint coat which binds the wearing surface to the foundation will adhere.

A Mining and Tunneling Machine

The Jackson mining and tunneling machine, illustrated herewith, is for excavating in rock; it is claimed the machine will reduce the cost of rock excavation in tunnels and mining properties by as much as 70 per cent. It is claimed that the device will eliminate the use of explosives.

This machine is designed to carry in suspension all portable tools, thus increasing their utility and range of operation.



A NEW MINING AND TUNNELING MACHINE.

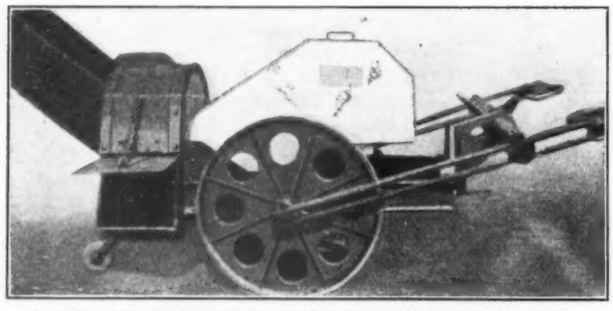
The tool holder has proved a necessity in facilitating the use of pneumatic riveters, chippers, busters, blacksmithing tools, jackhamers, tamping tools, electric grinders, drills, coal cutters, etc.

This machine is recommended for use in excavations in rock, hardpan and clay tunnels, for cutting asphalt and pavements of all kinds, breaking concrete and frozen ground, and for driving sheeting and tamping earth during backfilling operations.

It is caimed that the tool holder will reduce the cost of operating portable tools by from 25 to 50 per cent.

A Rotary Paddle Wheel Box Car Loader

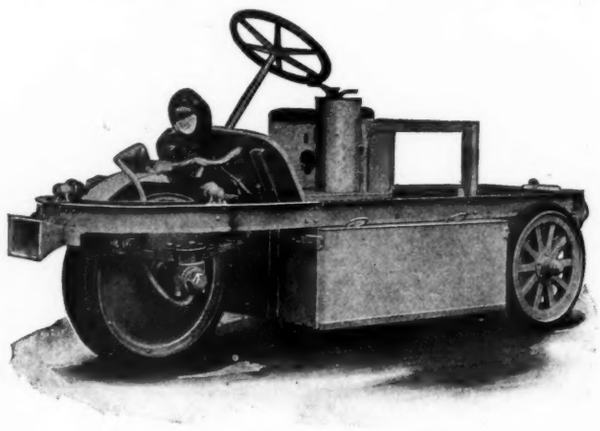
The Ottumwa portable, rotary, paddle wheel box car loader is for loading sand, gravel, crushed stone and other small bulk materials. It is claimed that one man with this loader will do the work of from four to ten laborers. The loader has few working parts. It is of rigid and strong construction. The material to be loaded is received in a circular receiving chamber through a gravity chute and is discharged to either end or the car by means of a four-blade paddle wheel revolving in this chamber. The distance and height to which this material is discharged is regulated by a hinged plate over either opening. An electric motor of 8 to 10-h.p. furnishes power. It is mounted on a portable truck and can be wheeled by man power from one point to another.



VIEW OF PORTABLE, PADDLE WHEEL BOX CAR LOADER.

An Efficient 3-Wheel Tractor

The Couple-Gear 3-wheel tractor, with one pulling wheel forward, is adaptable to the handling of wagons loaded with commercial freight over ordinary city streets. In using this tractor no change is made in the wagon, or the method of handling the wagon, with the exception that the wagon pole tongue is removed and a short bale tongue is substituted.



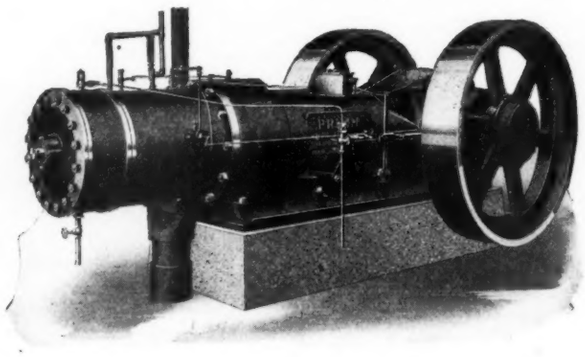
COUPLE-GEAR 3-WHEEL TRACTOR.

This machine is offered in the one-wheel drive only, for use over city streets or tramways. It is also built with all three wheels as drivers, for use under more difficult conditions.

It is claimed that one man with the tractor, used in conjunction with two wagons, one wagon being loaded while the other is being delivered, can handle more than two men with teams.

An Improved Oil Engine

The Primm oil engine is built to deliver cheap and safe power. It is a heavy-duty engine, operating on fuel oil, crude oil, kerosene or distillate. It is not a gasoline engine with an oil attachment. The development of this engine has been under way since 1902. It is a semi-Deisel engine, that is, the



VIEW OF PRIMM HEAVY-DUTY OIL OR DISTILLATE ENGINE.

pressure employed in the cylinder is between the high-compression Deisel type and the ordinary low-compression engine.

The horizontal, single-cylinder, two-cycle, crosshead construction is used in preference to any other type to get away from three faults of the vertical type, namely, inaccessibility of bearings, difficulty in removal of crank shaft and piston and difficulty of proper lubrication of the cylinder. The single cylinder was adopted to eliminate working parts. The line comprises engines from 15 to 150 h.p., all of the single-cylinder, two-cycle type. These engines are adaptable to any kind of work. They are made by the Power Manufacturing Co., Marion, O.

A Popular Line of Sanitary Carts and Wagons

When several of the suburbs, within a radius of 5 or 6 miles of Wheeling, W. Va., desired to make arrangements with the city to burn their garbage in the Wheeling crematory, the city officials insisted that the garbage be delivered to the crematory in sanitary wagons to prevent nuisance on the streets. As the Holzbog wagons owned by Wheeling were satisfactory to the officials of the suburbs, wagons of this type were purchased with the approval of the health department.

Prior to using Holzbog sanitary carts for garbage, night soil, etc., the city of Elkins, W. Va., hauled its garbage in open wagons, which were a menace to the public health as well as a nuisance. The carts were found, after due trial, to be sanitary in all respects as well as convenient.

VIEW OF HOLZBOG SANITARY WAGON, USED FOR HAULING WET GARBAGE, ETC. CIRCULAR TYPE OF BOTTOM FACILITATES CLEANING.

J. A. Magruder, City Engineer, Danville, Va., reports three 4-wheeled Holzbog dump carts in the service of his city. They are used for night soil, wet garbage, etc. He finds that the circular bottom of these cart beds, reducing corners and angles to a minimum, makes them very easy to clean, and with the close-fitting cover they are as near odorless as a cart used for these purposes can well be.

The village of Hibbing, Minn., has 4 steel garbage wagons of Holzbog manufacture. They are of 65 cu. ft. capacity. They have been used for 2 years in hauling to dumping grounds 3 miles from town without complaint of odors from the wagons.

Gravity Brick Conveyors Save Time and Money for Contractors

Brick paving contractors find that a big saving in time and money is effected in the use of gravity brick conveyors. Thus C. W. Hughes of Malta, O., who has a 16-ft. carrier section in service, reports the placing of 32,000 paving brick in a day when using a conveyor with 8 men, and only 18,000 brick by the wheelbarrow method with 10 men. On this job, in Guernsey County, the street width was 30 ft. Two men placed brick on the carrier, six men stacked for setters and there was one setter and one helper.

Springer & Rogers of New Philadelphia, O., have two 16-ft. and one 8-ft. section, with which they lay an average of 28,000 brick per day. Their biggest day was 36,000 brick, using 14 men on brick and 6 men on the cushion. The street width was 46½ ft. Four men placed brick on carrier, 8 men stacked for setters and 2 men set brick.

H. K. McCollum of Fort Worth, Texas, has two 16-ft. carrier sections. He places from 30,000 to 50,000 brick per day. Using the carrier and 10 men he placed 52,000 brick in one day. On this job the street width was 46 ft. Two men placed brick on the carrier, 5 stacked and 1 man set brick.

The Adams Bros. Contracting Co., of Zanesville, O., have 2 16-ft. carrier sections. They lay 25,000 brick per day on the average. Their best day with the wheelbarrow system and 12 men was 30,000 brick, and with the conveyor system and 9 men, 32,000 brick. This was on a 16-ft. width of street with 4 men putting brick on the conveyor, 4 men stacking and 1 setting brick.

The Smith Engineering and Construction Co. of Warren, O., have had two 16-ft. carrier sections for several years. They lay between 20,000 to 30,000 brick per day on the average; 30,000 was their best day, with 10 to 11 men. This was on a 30-ft. street, where 4 men placed brick on carriers, 4 to 6 men stacked and 1 man set brick. This company never used the wheelbarrow method. Before purchasing carriers they carried the brick by hand. They state that the conveyors enabled them to dispense with the services of 4 men.

The W. M. Brode Co. of Newcomerstown, O., have one 16-ft. carrier section in service. They lay, on the average, 25,000 brick a day. Their biggest day, with 10 men, was 30,000 brick. This was on a 16-ft. street with 6 men placing brick on carrier, 3 men stacking and 1 setting.

McAlonan Brothers of Akron, O., have two 14-ft. carrier sections. Their average is 21,000 brick laid per day. Their best day using the brick tong method and 22 men was 28,000. Their best day with the gravity brick conveyor and 14 men was 40,000 brick laid. This was on a 36-ft. street, where 4 men placed brick on the carrier, 8 men stacked and 2 men set brick. The conveyor system cut 8 men off the payroll on this job and more work was done than with the larger force.

The A. C. Loomis Co. of Mattoon, Ill., have two 16-ft. carrier sections and lay 28,000 brick per day on the average. Their best day was 30,000 brick laid, using 10 men; 4 placing brick on carrier, 4 stacking and 2 setting.

Henderson Brcs. of Coshocton, O., have two 14-ft. carrier sections. They lay 20,000 brick per day on the average. The largest number of brick they placed in one day, with 8 men, by the wheelbarrow method, was 30,000. The largest number placed in one day, with 8 men, by means of the conveyor system, was 40,000. This was a 30-ft. street job. Four men placed brick on the carriers, 2 men stacked and 2 men set

brick. Thus the output of the gang was increased 33% per day by the use of the conveyors.

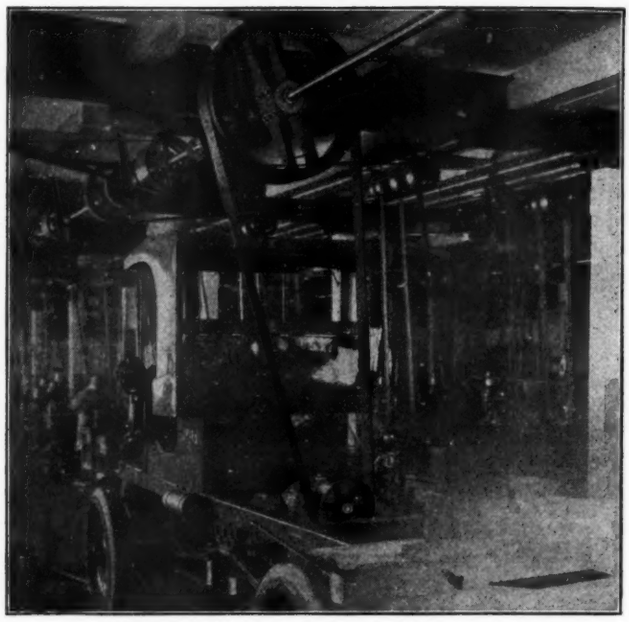
In all the foregoing cases the conveyors used were the Matthews gravity brick conveyors. The contractors found that these carriers saved rehandling the brick, insured having the right number of brick at hand and obviated chipping and breaking of brick. They report ease in adjusting the conveyor sections to fit various widths of streets. The carriers bring the brick to the setters clean and keep mud off the newly laid brick until after the joint filler has been poured.

Motor Truck Furnishes Power to Operate Tool Room of Factory

Recently a Duplex 4-wheel drive motor truck supplied power to operate a department of a factory which otherwise would have been forced to close.

When the flood waters of the Grand River at Lansing, Mich., made impossible the operation of the Michigan Power Company's plant among the scores of factories affected was that of the Duplex Truck Company.

However, it was not necessary to close the Duplex tool room because of a novel arrangement whereby power was furnished in this department by a Duplex truck. A pulley wheel was attached to the rear of the chain case shaft of the truck and a belt transmitted the power to the line shaft above. The Duplex supplied ample power to operate all the machinery in the tool room.



MOTOR TRUCK SUPPLYING POWER TO OPERATE PART OF FACTORY IN AN EMERGENCY.

ADVANCE INFORMATION ON BIG JOBS

Further Information on Roads Reported to Washington by the States as Vitally Necessary

In the April issue of MUNICIPAL ENGINEERING information was published on pages 163-167 covering the roads reported to the U. S. Office of Public Roads and Rural Engineering by several of the states as vitally necessary to the transportation system and as aids to increased agricultural production. The data given in that article covered the following states: Florida, Illinois, Indiana, Kansas, Maine, Michigan, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, Rhode Island, Tennessee, Utah, Washington and Wisconsin.

The present article gives similar information covering the following additional states: Alabama, Colorado, Connecticut, Idaho, Maryland, Massachusetts, New York, North Dakota, Ohio, Oklahoma, South Carolina, Texas and Wyoming. In every case the information given is taken directly from letters to the editor by officials of the several state highway departments.

Alabama

W. S. Keller, Engineer, State Highway Department, Montgomery, writes:

"Prior to the passage of the Federal Aid Road Law, Alabama, by legislative enactment, had designated a system of state trunk roads, state aid being limited to this system, except where all trunk roads in a county were completed. The Secretary of Agriculture ruled that Federal aid, likewise, would be limited to this system. Twenty-six projects were submitted to and approved by the Secretary of Agriculture before the State Highway Department was requested to designate the relative essential military value of the roads to be constructed. All of these projects having been approved and nearly half actually under construction, consent was given for the construction of the entire number. One project located in a county where the trunk road system was already completed, and not having been approved, has been held up pending more definite information as to its military value. Construction work on twelve projects involving a total expenditure of $279,937.43 is now well advanced. The twenty-six projects approved carry a total estimate of $580,515.17, of which $283,051.85 will be paid by the government.

"We could not anticipate our work under the Federal allotment for the fiscal year 1919, as under our law the counties have to supply the greater portion of the state's fund and file request for Federal aid by April 8.

"A number of the projects are being held up on account of inability to secure railroad transportation.

"Eight state aid projects involving a total of $62,808.71 are under way and will be completed within six months.

"All of the work mentioned, both Federal and state, is confined to bad links in the state trunk road system. About 3,000 miles are comprised in this system, of which not more than 1,200 miles remain to be constructed."

Colorado

J. E. Maloney, Chief Engineer, State Highway Commission, Denver, writes:

"For 1918 the expenditures will be somewhat larger than for 1917, as most of the counties have levied slightly increased taxes for road and bridge purposes, but the amount of actual work performed will probably not be increased, as the increased wages and cost of materials will probably offset the increased amount available."

In 1917 the grand total of all funds expended by or under the supervision of the State Highway Department, exclusive of fiscal costs, amounted to $1,470,000. Of this amount $703,000 was from state funds and $767,000 from local funds.

Connecticut

Charles J. Bennett, State Highway Commissioner, Hartford, writes as follows concerning the participation of the state in the improvement of roads especially desired by the United States government to assist in the prosecution of the war:

"Late last year this department constructed a section of road between Groton Center and the submarine base, on the east side of the Thames River, at the request of the War Department. This improvement was approximately two miles in length.

"The state will very shortly start work on the improvement of the extension of this road from the submarine base north to the city line of Norwich, Conn. This also is an improvement desired by the State Council of Defense.

"With reference to your inquiry concerning the work that counties are to do, be advised that the counties in Connecticut have no jurisdiction whatever over road work, with the exception that in event a town neglects to repair a road (other than a state road) a petition may be brought to the county commissioners, and they can order a town to make proper repairs. In event the town does not carry out the instructions of the county commissioners the county may then repair the road and collect the cost from the town at fault.

"We quote from a letter written February 8, 1918, to the chairman of the executive committee of the American Association of State Highway Officials:

" 'The construction work to be undertaken is confined to the main roads, having in mind Director Page's statement regarding the advisability of constructing only such roads as serve through traffic.' "

Idaho

H. C. Allen, State Highway Engineer, Boise, writes:

"We contemplate the construction of a portion of the north and south highway between Grangeville and Whitebird, in Idaho County, a distance of 22 miles, at a total cost of $247,000. This road is the only possible route connecting north and south Idaho and will help to open up large cattle and farming country and gives easy access to forest areas adjacent thereto. This is known as project No. 6 and is first in importance.

"Also a portion of the Sawtooth Park highway in Lemhi County, between Salmon City and the Pahsimoroi River, a distance of 38 miles, at a total estimated cost of $300,000. This road will serve a large fertile farming section and will be the only road between the Pahsimoroi River valley and the railroad terminus of Salmon. This is a part of the trunk road through central Idaho to Montana. This road is known as project No. 5 and is sixth in importance.

"Also three sections of the Lost River highway in Custer County, between Mackay and Challis. We are desirous of constructing about 39½ miles of this road. The total distance between Mackay, railroad terminus, and Challis is 57 miles. The first stretch, between Mackay and Dickey, a distance of 18 miles, is estimated to cost $77,500; the next stretch, between Dickey and Challis, a distance of 20 miles, at a cost of $70,200, and the third stretch, a distance of 1½ miles, between Dickey and Challis, at a cost of $7,300. The total on the three projects being $155,000. These are known as projects Nos. 2, 3 and 4 and are third, fourth and fifth in importance, respectively.

"This road is a link in the only road between Mackay, railroad terminus, and Challis, also to large mining district along the upper Salmon River. All minerals from this mining section are now freighted to Mackay as well as the stock and farm produce from Challis and vicinity. This road is a link in the road between Mackay, Challis, Salmon and other points beyond.

"We are desirous of constructing these roads this year and are submitting all the data and project statements on same to the District Engineer, U. S. Office of Public Roads.

"In addition to the above we expect to construct about twelve miles of the North Pacific highway in Kootenai in connection with Section 8, Forest Service, of the Federal Road Aid act. This stretch of road will cost about $150,000."

Maryland

H. G. Shirley, Chief Engineer, State Roads Commission, Baltimore, writes:

"I have been unable to advise you before this what work the State Roads Commission contemplated doing during the coming two years as the Legislature was in session and we did not know how much money would be available. However, the Legislature adjourned yesterday, April 2, and I am glad to say they appropriated us something like $8,000,000 for the next two years for construction and maintenance. The commission will get together some time in the near future and lay out a plan for the expenditure of this money."

Massachusetts

A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Boston, writes:

"The roads sent on the schedule with estimated costs and with descriptions showing their importance were forwarded to the U. S. Office of Public Roads and Rural Engineering early in March and are as follows:

"In town of Hanover, Plymouth County, between town of Norwell and town of Kinston (Boston to Plymouth). Estimated cost, $39,000. This is a missing link on the main inside and shortest line between Boston and Plymouth. It intercepts important cross roads to Brockton, Rockland and many towns. It is all through a farming district supplying milk, produce, etc., to the industrial centers.

"In Malden, Melrose, Saugus, counties of Middlesex and Essex, being road from Boston to Newburyport. Estimated cost, $28,200. This is on the main inside line from Boston to Newburyport and so on to all points in New Hampshire and Maine. The shortest route as well—connects Boston and the metropolitan district with farming communities, Essex County, etc. Essex County farm products, 1910 census, $2,796,000 a year.

"In Danvers, county of Essex, being road from Salem to Lawrence. Estimated cost, $31,000. Main line between Lawrence, Haverhill and Salem. Road built for 8 miles to Middleton, and macadam, though old, through the town. All through farming country. See Essex County figures.

"In Windsor and Dalton, county of Berkshire, route from Northampton to Pittsfield. Estimated cost, $78,000. Main through route, Albany, N. Y., Pittsfield, Mass., Northampton, Springfield and Boston. All through farming country towns from 7 to 14 miles from railroad. The highway is their only outlet. One of 3 main routes east and west through the state. Northern route has heavy grades and is impassable in winter and spring.

"In Sandwich, county of Barnstable, route from Sandwich to Mashpee. Estimated cost, $20,000. This is the link connecting Sandwich village with Mashpee, Cotuit, Falmouth, etc. It runs through a farming community, rural mail route.

"In Cummington, county of Hampshire, on route from Northampton to Pittsfield. Estimated cost, $124,000. This is a continuation and completion of a bad stretch of road on main route. See Windsor. Most of the rest of the route is macadam or a fair gravel road. Completes this main route.

"In Athol and Petersham, Worcester County, route from Athol to Worcester. Estimated cost, $163,000. Main line, all through a farming country, from the city of Worcester to Athol. Main line in Worcester County from Athol, goes to New Hampshire and Vermont. Yearly value of agricultural products, Worcester County, $5,574,650—U. S. census, 1910.

"In Braintree, county of Norfolk, from Braintree to Quincy. Estimated cost, $45,000. This is on main line between Brockton, Mass., a very large manufacturing city (shoes) and Boston. Would be much used by trucks carrying leather, shoes, etc.

"In Littleton, county of Middlesex, from Littleton Common

to Groton. Estimated cost, $72,000. This is an uncompleted section on the main line from Boston to Keene, N. H. Practically the whole route in Massachusetts is macadam with a bituminous top or better, except for 7 miles in Littleton and Groton. Present road is a bad dirt road—impassable at times.

"In Saugus, county of Essex, on the route to Newburyport. Estimated cost, $90,000. This is another stretch and one of the worst on the Newburyport turnpike continuation of project No. 3, agreed to last year and 80% constructed. See Malden, Melrose and Saugus description."

New York

H. Eltinge Breed, First Deputy Commissioner, New York Commission of Highways, Albany, writes:

"With regard to our contemplated program this year, I would say that we have somewhat in the neighborhood of 1,100 miles of old contract work still in force. Of this amount 500 miles is physically completed and practically in use. Of of the remaining 600 miles, about 300 miles are torn up and about 300 miles have had no work done upon them. It will be our aim this year to finish the work on the contracts that have been torn up complete with surfacing.

"Last year we built almost 400 miles of road, so from that estimate you can see that the 300 miles I said we hoped to complete will be about what we will actually get done this year, owing to present conditions.

"The completion of this work will involve the importation of about 500,000 tons of material, so that if one-half of it is completed, there will be car supply necessary for transporting about 250,000 tons. As some of this can probably be carried by motor truck, it will not mean quite the full car equipment that will be necessary to carry the 250,000 tons."

North Dakota

Jay W. Bliss, State Engineer, Bismarck, writes:

"The total mileage of the proposed state roads is approximately 42,000. It is the opinion of the State Highway Commission that a state highway system consisting of about 2,000 miles could have been developed more rapidly and would have been of almost equal service to the people of the state. However, the Highway Commission is of the further opinion that by paying special attention so far as is possible to the prior development of trunk lines excellent results will be obtained. I may say in this connection, however, that such state aid as is available in North Dakota is primarily for the purpose of placing the state in a position where it may benefit under the provisions of the Federal Road Act. This, together with the necessity of complying with the government requirements relative to post routes has placed the Highway Commission in many counties in an embarrassing position. The State Highway Commission has submitted a schedule to the Federal government covering 26 different projects in 20 different counties, and are preparing 6 more, which will be submitted in time for construction this year. While, under the conditions that exist in North Dakota, it has not been possible to secure projects, which in all instances are continuous, it is felt from a state-wide standpoint those selected are particularly fortunate in that in all instances the improvement of such roads will result in decreased cost in transportation of agricultural and other products, and in greater speed and reliability in the movement of such materials."

Ohio

H. D. Brunning, Chief Highway Engineer, State Highway Department, Columbus, writes:

"The Federal government has very promptly responded in the matter of approval of Federal aid projects which were presented to them by this department some time ago, and I believe that the Office of Public Roads is doing everything possible to help this department and the public in the consummation of the improvements contemplated for the season 1918. The projects approved by the Office of Public Roads in the order of their importance are as follows:

"First: National Road, I. C. H. No. 1, Muskingum County, Zanesville to New Concord, 13.63 miles. Estimated cost, $488,500.

"Second: Cleveland-Buffalo road, I. C. H. No. 2, Ashtabula County, Ashtabula to Conneaut, 11.93 miles. Estimated cost, $431,799.

"Third-A: Lincoln highway, I. C. H. No. 141, Ashland County, east of Ashland, 2.473 miles. Estimated cost, $68,000. Third-B: Lincoln highway, I. C. H. No. 141, Wayne County. From Jefferson village to Ashland County line, 6.71 miles. Estimated cost, $170,541.95. Third-C: Lincoln highway, I. C. H. No. 140, Richland County. From Ashland County line west 3½ miles. Estimated cost, $100,000.

"Fourth: Cleveland-Buffalo road, I. C. H. No. 2, Lake County, Painesville to Geneva, 13.17 miles. Estimated cost, $459,379.28.

"Fifth: Akron-Cleveland road, I. C. H. No. 16, Summit County. From Akron to Cuyahoga County line, 16½ miles. Estimated cost, $800,000.

"Sixth-A: National road, I. C. H. No. 1, Madison County. West Jefferson to Clark County line, 12.9 miles. Estimated cost not made. Sixth-B: National road, I. C. H. No. 1, Clark County, 2½ miles east of Springfield to Madison County, 9.28 miles. Estimated cost not made.

"Seventh: River road, I. C. H. No. 51, Lucas County. Maumee to Waterville, 8.21 miles. Estimated cost, $167,200.

"Eighth: Columbus-Wooster road, I. C. H. No. 24, Ashland County. Loudonville south, 1.542 miles. Estimated cost, $46,500.

"Ninth-A: Columbus-Wooster road, I. C. H. No. 24, Knox County. Mt. Vernon to Amity, 4 miles. Estimated cost, $163,893.40. Ninth-B: Columbus-Wooster road, I. C. H. No. 24, Knox County. Mt. Vernon south, 2 miles. Estimated cost, $65,289.13.

"Tenth: Cleveland-Wooster road, I. C. H. No. 25, Wayne County. Jackson to Bloomington, 5 miles. Estimated cost, $140,662.50.

"Eleventh: Bryan-Edgerton road, I. C. H. No. 309, and Bryan-Wauseon road, I. C. H. No. 297, Williams County. Edgerton west to Indiana state line and from Fulton County line west about 6 miles, in all a length of 8.75 miles. Estimated cost, $215,000.

"Twelfth: Milford-Chillicothe road, I. C. H. Nos. 9 and 258, Highland County, 22½ miles. Estimated cost, $347,000.

"Thirteenth: Cambridge-Caldwell road, I. C. H. No. 353, Guernsey County. Byesville south to 2.33 miles. Estimated cost, $92,384.44.

"Of the above, Nos. 1, 3-A, 7 and 8, have been placed under contract and work is in progress on same."

Oklahoma

Max L. Cunningham, State Engineer, Oklahoma City, writes:

"I have recommended to the authorities at Washington the construction of five projects, as follows:

"Project No. 1: A bridge across the South Canadian River, about 10 miles south of Oklahoma City.

"Project No. 2: A road about 25 miles long, leading into the town of Broken Bow, McCurtain County, Oklahoma, from a rich agricultural district to the northwest of that county.

"Project No. 3: A road running east from Oklahoma City, past the State Capitol Building, which is now part of a motor truck route.

"Project No. 4: A road from the city of Lawton, Oklahoma, to Camp Doniphan and Fort Sill, where connection is made with the roads within the military reservation.

"Project No. 5: A road about 16 miles long, from the city of Durant, Okla., to the north line of Bryan County, which will relieve the M., K. & T. Ry. of heavy local freight movements, by fostering the use of motor trucks.

"The state, in addition to the Federal government fund and

the full appropriation made to meet same, is expending the sum of $1,000,000 as a state aid fund to counties on the construction of permanent features on state roads in each county and is expended only in connection with an appropriation in equal amount made by the counties."

South Carolina

F. H. Murray, Acting State Highway Engineer, Columbia, writes:

"Herewith is a short statement relative to the schedule forms sent us by the U. S. Office of Public Roads in regard to proposed Federal aid projects for this year in South Carolina:

"At a recent meeting of the South Carolina State Highway Commission estimates were approved for Federal aid work in a number of counties.

"In order to arrive at a tentative program for 1918 Federal aid work in the counties, the commission recently submitted to the United States Office of Public Roads in Washington for its approval the following schedule of Federal aid projects. The United States Office of Public Roads has tentatively approved of the expenditure of the amounts shown below on these projects. Several of these counties have complied with the conditions of the Federal Aid Act by supplementing the amount of their apportionments.

"The counties listed below have all filed with the State Highway Commission written application requesting their apportionment; however, several of them have not yet arranged to supplement these funds.

"It is worthy of note that the projects listed below may all be considered of military value, as they assist in bringing produce to market and shipping centers. The first three projects listed are for roads leading to cantonments:

County	F. A. Funds
Richland (for road to cantonment)	$23,248.20
Spartanburg (for road to cantonment)	48,577.87
Greenville (for road to cantonment)	20,000.00
York (for road)	18,378.84
Chesterfield (for road)	5,570.93
Union (for bridge)	10,881.06
Chester (for bridge)	10,881.06
Horry (for bridge)	2,500.00
Marion (for bridge)	13,183.88
McCormick (for road)	11,201.99
Cherokee (for road)	16,802.99
Horry (for road)	16,284.88
Chester (for road)	12,600.04
Bamberg (for road)	10,771.14
Pickens (for road)	14,648.76
Newberry (for road)	19,129.55
Edgefield (for road)	12,322.19

"Projects in Greenville and Spartanburg Counties for roads leading to Camp Sevier and Camp Wadsworth are now under construction and it is proposed to start construction of several additional projects in the near future."

Texas

George A. Duren, State Highway Engineer, Austin, writes:

"Herewith is an abstract giving the mileage and total estimated cost of all the Federal aid projects in Texas:

Con. Order No.	Mileage	Total Est. Cost
1. Hays	24.8	$43,131.00
2. Travis	6.0	25,389.10
3. Dallas	1.0	20,000.00
4. Wichita	8.9	87,737.10
5. Harris	3.2	113,221.22
6. Bexar	18.18	110,080.76
7. Williamson	21.5	106,375.50
8. McLennan	3.5	25,000.00
9. McLennan	3.0	25,000.00
10. McLennan	1.25	10,000.00
11. Harris	4.6	48,592.00
12. Johnson	33.89	89,365.00
13. Lee	6.35	20,000.00
14. Ward	17.5	26,141.50
15. Brooks	20.0	42,077.75
16. Culberson	50.4	45,256.55
17. Caldwell	15.8	77,120.00
18. Fayette	11.0	73,546.00
19. Titus	8.0	56,040.00
20. Titus	11.25	19,800.00
21. Dallas	3.0	20,000.00
22. Dallas	3.0	14,000.00
23. Dallas	3.0	20,400.00
24. Morris	10.88	65,200.00
25. Tarrant	10.0	68,740.00
26. Shackelford	9.0	29,956.00
27. Dickens	6.5	32,439.00
28. Wharton	3.3	23,526.70
29. Franklin	12.15	49,500.00
30. Eastland	28.3	110,145.20
31. Guadalupe	15.7	69,789.56
32. Robertson	5.5	27,990.50
33. Madison	21.8	87,500.00
34. McCulloch	37.4	75,774.60
35. Tarrant	6.2	28,619.25
36. Tarrant	3.2	24,343.00
37. Walker	5.3	14,341.80
38. Val Verde	4.9	27,000.00
39. Jasper	13.6	71,696.90
40. Gregg	14.6	40,500.40
41. Mason	24.9	22,533.50
42. Wise	42.3	170,000.00
43. Mitchell	7.5	25,867.60
44. Bell	36.93	100,000.00
45. Lamar	5.0	20,000.00
46. Lamar	6.0	24,000.00
47. Gillespie	18.6	41,899.00
48. Hemphill	17.0	19,646.00
49. Collingsworth	8.0	10,010.00
50. Coke	18.65	44,836.00
51. Nolan	13.7	43,973.00
52. Bosque	59.2	237,208.81
53. Callahan	12.1	50,453.70
54. Jefferson	5.4	89,968.00
55. Camp	8.0	69,816.00
56. Jefferson	5.6	94,237.00
57. Wilbarger	4.66	97,136.00
58. Navarro	11.8	133,102.00
59. Calhoun	10.0	23,594.00
60. Randall	19.0	24,766.56
	821.79	$3,308,383.56

"Average cost per mile, $4,025.82."

Wyoming

Z. E. Sevison, State Highway Engineer, Cheyenne, writes under date of April 4, as follows:

"In regard to our report on essential highways for 1918 construction, this report was sent to Washington last month and I have been advised by the director of the Office of Public Roads that our program for this year has been approved without exception.

"This program of Federal aid in Wyoming includes 15 projects, for which the estimated cost is approximately $600,000. The plans for 14 of these projects have been completed and submitted to the Office of Public Roads. Four sets of plans have been approved to date and one project is now being advertised. It is believed that all of these plans will be approved not later than April 15th.

"Surveys for one project in Sheridan County, consisting of 8 miles of hard surfaced road, are now being made, the esti-

mated cost of this project being $200,000, and it is expected that the project will be completed this year.

"The state aid work is limited on account of the small amount of state funds available for work of this kind. However, the funds have been apportioned to the various counties and a program agreed upon in nearly all of the counties. This work consists principally of bridges, but in some cases the work will be on construction on the Lincoln highway and the Yellowstone highway.

"The work being done independently by the counties does not come under this office and we have no means of knowing just what will be done, but it will be of practically the same class of work as is usually done by local authorities, which is simply patchwork here and there, with no really permanent construction.

"The counties will probably spend about $400,000 in the state this year for this class of work."

Iowa

Thos. H. MacDonald, Chief Engineer, Iowa State Highway Commission, Ames, writes:

"Concerning our federal aid projects, I will say that the projects which the commission has under way for this year have been approved by the Federal Department, and involve the building of the following roads:

Earth roads	238.6	miles
Gravel roads	107.7	miles
Concrete roads	5.07	miles
Brick or concrete	3.3	miles

Chicago Awards Paving Contracts Aggregating Over $800,000 and Expects Normal Paving Year

Prospects are that Chicago will spend a normal amount of money for street pavement construction this year in spite of the war. On April 3, 1918, bids were opened for the first letting of the year. This letting covered 15 miles of pavements and the bids of the successful bidders aggregated $803,759.80.

In addition to this work, approximately 28 miles of special assessment paving contracts, aggregating $1,612,580, carried over from previous years, will be executed this year. Virtually, this entire sum is for work just started which will be done this season.

Other street improvement work for which special assessments have been confirmed and which Chicago is ready to receive bids on, aggregates about 20 miles.

Since the first of October, 1917, to the middle of April, this year, there were filed with the special assessment department of the board of local improvements over 500 preliminary pavement estimates.

Contracts Awarded at First Letting

Among the successful bidders at the big letting held on April 3, when over $800,000 worth of contracts were awarded, are: The Ryan Company, Smith & Brown Company, the American Asphalt Paving Company, Ready & Callaghan Coal Company, R. F. Conway Company, Contracting & Material Company, Calumet Coal & Teaming Company, Citizens' Construction Company, James A. Sackley Company, Marquette Construction Company and Farr Brothers Company. Some of the biggest street paving contractors in Chicago are represented in this list.

The types of paving covered in these awards are: Creosoted wood block on 1-in. of Portland cement mortar and 6-in. of Portland cement concrete, joints filled with coal tar, surface dressed with ¼ in. of torpedo sand; vitrified paving brick on 1 in. of Portland cement mortar and 6 ins. of Portland cement concrete, joints filled with asphaltic filler, surface dressed with ¼ in. of sand; asphalt on 6 ins. of Portland cement concrete, swept with natural hydraulic cement; 2½ ins. of granite or trap rock bonded with asphaltic cement; 8 ins. of blast furnace slag or 8 ins. of limestone and 2¼ ins. of limestone bonded with asphaltic cement, top dressed with ¼ in. granite screenings; granite blocks on 2 ins. of sand and 6 ins. of Portland cement concrete, joints filled with gravel and coal tar, surface dressed with ¼ in. of gravel.

M. J. Faherty, President of the Board of Local Improvements, believes firmly in the economic importance of public improvements and is going ahead with the work.

GENERAL ARTICLES

Construction Methods and Equipment Employed in Construction of Suburban Telephone Conduits

A telephone company operating in one of the largest cities of the country and in the contiguous suburban territory has an especially alert and progressive construction department in its suburban plant division. The data here presented are drawn from the experience and observation of the superintendent of construction of the suburban plant division, and their authenticity is vouched for by the editor of MUNICIPAL ENGINEERING.

Trenching

The company had two important pieces of suburban conduit construction in 1917; both were rush jobs. It was decided to use a trenching machine, so the company purchased a Type 122, Pawling & Harnischfeger excavator at a cost, delivered, of $3,277. The machine was placed in operation on April 27, 1917. The total amount of conduit constructed was 61,000 trench feet; the machine was used on 54,000 trench feet. The maximum cut was 5 ft. 6 ins. and the average cut 3 ft. 6 ins. The trench width was 15 ins.

On the first job the soil was two-thirds blue clay and one-third black dirt. There was some solid rock, some gravel and boulders encountered. On this job there was much rain and one cyclone.

On the second job the soil was one-third gravel and two-thirds light earth, with a considerable quantity of large boulders. Ideal weather conditions prevailed. Each job took about two months, the second immediately following the first.

The superintendent states that this excavating machine will operate efficiently, except in rock, in very wet, heavy, black soil that gums the buckets, and in heavy gravel, where there are many boulders exceeding 10 ins. in diameter.

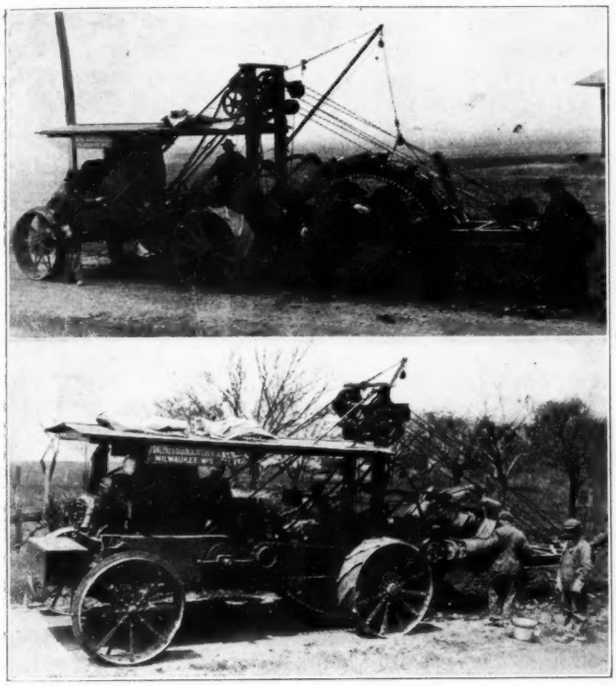
On the work here described soil overlying rock was stripped off by the machine. The rock was then drilled and blasted as later described.

The maximum length of trench dug in a day of 10 hours was 1,695 lineal ft. The average was 832 trench ft. per day, *counting in all the bad days.* The machine can average 150 ft. per hour in a trench 15 ins. wide and 3 ft. 6 ins. deep.

The superintendent, who represents a great and conservative company satisfied with nothing short of the best work obtainable, recommends the overhauling of the machine after

every five miles of trenching. The cost of this overhauling, he finds to be about $175 on the average and it requires three days' time. If this is done, the machine has a useful life of 150 miles of trench.

On this suburban work it is necessary to keep to the side of the road. The machine can be used on a slope by blocking up the wheels on one side as much as 3 ft. The blocking is



VIEWS OF TYPE 122 PAWLING & HARNISCHFEGER TRENCH EXCAVATOR DIGGING TRENCH FOR SUBURBAN TELEPHONE CONDUITS.

done with 3x12-in. maple planks. Naturally unusual care must be exercised in operating the machine on this country roadside work and the speed of operation is correspondingly reduced.

The machine trench was successfully cut for a length of two miles across gas service connections into every house. Where the location of a service was known the excavating wheel was raised and the service cut by the gas company. Some services were struck and broken without damage to the machine. The machine has a dependable slip clutch system for stopping when solid rock or other relatively immovable obstacle is struck. The superintendent says the machine is of very strong construction. It was moved 6 ins. laterally without damage in a cyclone.

This machine can move from one job to another over country roads at the rate of 1½ miles per hour. On this work it was so run for a distance as great as 20 miles between jobs. On such runs the cleats should be removed from the wheels. In cross-country running contractors should watch the bridges and culverts, shoring them up where necessary, as the machine naturally is heavy.

A statement of the daily operating expense of this machine on the work here described, done in 1917, follows:

Item	Cost
20 gals. of gas at 20 cts.	$4.00
2 gals. of oil at 45 cts.	.90
Engineer's salary and board	6.00
Helper (watched oiling, tension on belts, helped raise and lower wheel, relieved engineer, etc.	3.50
2 laborers blocking wheels and removing boulders or cleaning mud from buckets at $3.50	7.00
10 men to trim up trench on bottom to rigid line and grade at $3.50	35.00
Depreciation, basis 150-mile life	3.32
Interest on investment	1.66
Repairs	6.65
Total daily operating expenses for 832 trench ft., av.	$68.03

Average cost per trench ft., 8 cts.

Hand labor for same work would cost 25 to 30 cts. per trench foot at same wage scale.

The superintendent says that the machine saved his company $10,500 on these two jobs and would have saved much more, but for the extreme care exercised in cutting the trench to a mathematically exact line and grade. It also made a big indirect saving of time and money by avoiding the labor troubles which surely would have been experienced had all hand labor been used.

The superintendent gives it as his judgment, based on experience, that this machine will cut trenches of this depth and difficulty at a cost of 1 to 2 cts. per trench foot under most favorable conditions in good soil and where it is unnecessary to adhere to exact line and grade. He considers the machine particularly well adapted for cross-country pipe mains, and for trenching for light gas and water mains, wherever other

VIEWS SHOWING CONSTRUCTION OF TELEPHONE CONDUIT IN SUBURBAN DISTRICT.
Left: Machine Excavated Trench. Right: Mortar Patch at Joints and Concrete Around the Four-Duct Vitrified Clay Conduit.

mains are not in the way, up to a trench depth of 6 ft. and width of 21 ins.

Design of the Conduit

The conduit was laid with 4-duct, vitrified clay tile, made by the Clay Products Co. of Brazil, Ind. The sections were 10x10 ins. and 3 ft. long. In dry ground and under light traffic, the tile was laid without a concrete base, but with a 3-in. concrete covering. In wet soil the tile was laid on a concrete base 4 ins. thick and was covered with a 3-in. layer of concrete, earth being tamped in at the sides of the tile. Where the traffic across the line of the conduit was very heavy, or where it passed under a railroad track, 4 ins. of concrete was placed entirely around the tile. The concrete was all mixed in machines. On this work manholes were spaced at about 500-ft. intervals. They were mostly of brick, but some were of concrete. The company would have used more concrete manholes, but could not develop a satisfactory knock-down form. There is a good form on the market, but the superintendent considers it very expensive.

Backfilling the Trench

In backfilling a machine was used, one that was on hand from a previous season. This machine was of the "Double Quick" type and cost $477 laid down. In operation this machine, made by the Waterloo Cement Machinery Corporation, requires an engineer and 2 men on the sweep. The itemized daily expense of operating this backfiller was observed as follows:

Item	Cost
Depreciation, 600 days' life	$0.80
Interest on investment	.28
Oil, gas and repairs	3.00
3 men (1 engineer, 2 laborers)	11.00
Total	$15.08

This machine displaced daily $27.50 worth of teams and scrapers (6 men and 2 teams). This was a saving of $12.42 per day at the rate of 1,000 ft. of trench backfilled per day. This machine is also found useful in the winter for pulling cable and on other work for which a winch is needed.

In discussing backfilling equipment, the superintendent referred colloquially to the P. & H. one-man backfiller as a "peach." He says it is strictly a one-man machine. It is a great machine where sufficient road clearance is available, but could not be used on this work, as the telephone company was not allowed to obstruct the road at all.

The backfill was not tamped by machine as this was unnecessary on this country road work. The backfilled earth was crowned to a height of 2 ft. over the trench where it was left for a time for the rains to settle. After this natural settlement had about run its course a 4-horse road roller was rented and run over the trench two or three times when the earth over the trench was nearly level again. Men followed the roller to fill in the low spots by hand. Two months after the completion of this work the line of the trench could not be traced on the ground.

The superintendent says the power tamping machine is the thing where it is necessary to repave safely over a new trench. He has used one of P. & H. manufacture on his city work at street crossings of his conduits and finds that the dirt can be put back as hard as concrete. He finds this machine useful also in cutting asphalt, where it works safely and economically. It is also serviceable for breaking up concrete pavement base. It was his experience that this machine will replace 10 good hand tampers.

Rock Drilling

On the trenching work where ledge rock was encountered the overburden was first removed with the trenching machine and the rock was then drilled and blasted. For the drilling a portable air compressor and rock drill was used. It was manufactured by the Zin-Ho Mfg. Co. of Chicago. It is size 42, and is driven by a 4-cylinder, 15-h.p. gas engine. The outfit comprised: Air compressor, drill head, drills, hose, housing, etc., and cost about $1,300. The cost of running this machine was $8 per day, including depreciation and all overhead charges. The superintendent said that the cost of drilling a 1-in. hole by hand to a depth of 24 ins. was $1.50 and by machine 50 cts. On one of the jobs here described this machine saved $1,200 and on the other $300.

This machine was used for setting telephone poles in rock as well as for drilling blast holes in rock trenching. It was also used to set a 500-gal. gas tank in solid rock at a saving over hand labor of $150. It was found useful, incidentally, in blowing up pneumatic tires. The superintendent said of this machine: "It is the goods. It will shoot the holes down in a hurry."

The accompanying illustrations show two views of the trenching machine and two views of the trench and conduit under construction.

Coming Conventions

WAR CONVENTION OF MACHINERY, TOOL AND SUPPLY INDUSTRY—This convention will be held in Cleveland, O., the week of May 13. It will be a joint war convention of four large national associations, namely, the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the National Pipe and Supplies Association.

AMERICAN WATER WORKS ASSOCIATION—Annual convention at St. Louis, Mo., May 13-17. Secretary, J. M. Diven, 47 State street, Troy, N. Y.

AMERICAN ASSOCIATION OF ENGINEERS—Annual meeting at Chicago, May 14. Headquarters at 29 South La Salle street, Chicago.

ALABAMA GOOD ROADS ASSOCIATION—Annual convention at Mobile, Ala., May 14-17. Secretary, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

ARKANSAS ASSOCIATION OF PUBLIC UTILITY OPERATORS—Annual convention at Hot Springs, Ark., May 21-23.

Personal Items

JOHN W. ALVORD, consulting engineer, of the firm of Alvord & Burdick, of Chicago, has been chosen consulting engineer to serve with Frederick Law Olmsted, city planner of Boston, and Burt L. Fenner, of McKim, Mead & White, the New York architects, to advise the Federal Department of Labor in connection with the housing program, which will involve an expenditure of more than $60,000,000.

R. A. MEEKER, formerly state highway engineer of New Jersey, has opened offices as a consulting engineer in Newark, N. J.

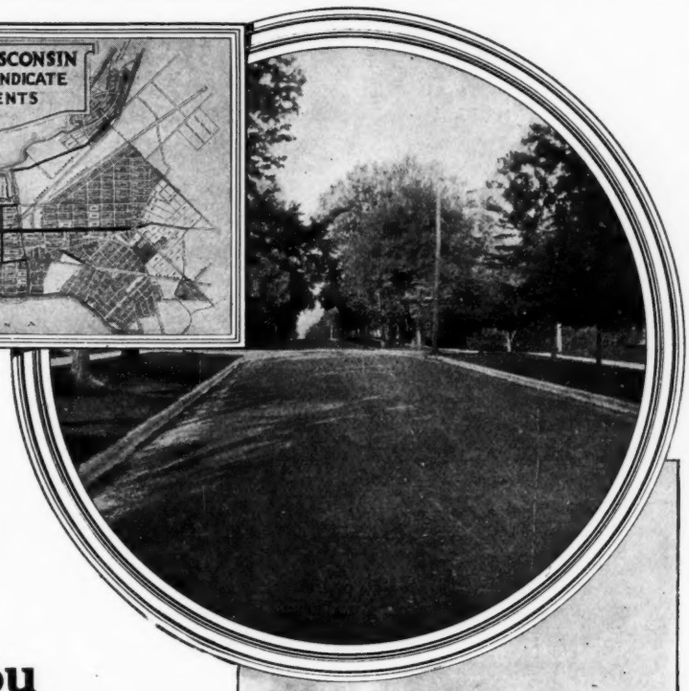
CHARLES BRADFORD, who has been connected with the work of the office of the engineer of Snowhomish county, Washington, with headquarters at Everett, for the past five years, has resigned that position to take another with the Washington Paving Company, of Seattle. He will serve the latter company as superintendent of paving.

H. G. SHIRLEY, formerly chief engineer of the State Roads Commission of Maryland, with offices in the Garrett Building, Baltimore, resigned that position to accept the position of executive secretary of the Highway Industries Association. He was succeeded as chief engineer on April 15 by J. N. Mackall.

WILLIAM H. COLLISON, JR., has been appointed city engineer of Ocean City, N. J., to succeed Morgan Hand, Jr., who resigned the office.

R. C. HARVEY has been appointed city engineer of Kent, O.

F. W. SIMONDS has been appointed city engineer of Rahway, N. J.



Tarvia

Preserves Roads
Prevents Dust

Let Us Introduce You to a Town that Believes in Good Roads—

Did you ever see a more interesting lay-out of a city than this of Madison?

Lake-fronts at top, bottom, and end, And what a waist-line! A lithe, young American city of the very best and most progressive type.

Its streets are its special care. Its motor-cars are so many, its trucking is so heavy, that the town demands streets that are dustless, mudless, and bumpless.

Therefore, it is a Tarvia town.

Note the black lines in the map: ***those are Tarvia streets—39 miles of them!***

Madison began with Tarvia in 1908. The people liked it so well that street after street has been treated with Tarvia.

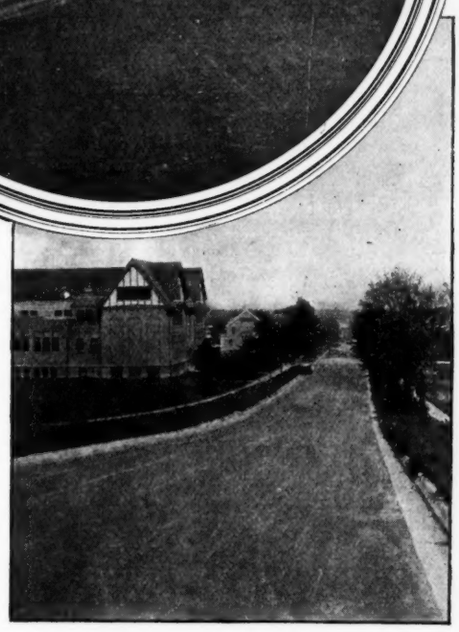
The officials gave the people what they wanted, namely, streets without dust, without mud, without noise, and ***without big maintenance expense.***

Madison continued to use Tarvia extensively during 1917 and the Tarvia mileage in Madison will be bigger this year.

The Street Superintendent has written recently in a published article about the streets of Madison:

> "We have been informed by officials from various cities who have visited Madison to inspect our streets and obtain cost-data of maintenance that we maintain our streets at a lower cost than any other city in this section."

Now, when the nation needs good roads so that motor-trucks can help out the great railroad congestion, it is more important than ever that every community should investigate the road proposition thoroughly.



Upper Picture—Madison Street, Madison, Wisconsin, constructed with "Tarvia-X," penetration method, 1912.
Lower Picture—Regent St., Madison, Wisconsin, constructed with Tarvia Topeka Mix on old macadam base, 1915.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems.

The advice of these men may be had for the asking by any one interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The Barrett Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
Detroit Birmingham Kansas City Minneapolis Nashville Salt Lake City Seattle Peoria

THE BARRETT COMPANY, LIMITED: Montreal Toronto Winnipeg Vancouver
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TRADE B MARK

CONTRACT NEWS

CONTRACTS AWARDED

ROADS AND STREETS

Ala., Montgomery—J. M. Wolfe & Sons, Decatur, awarded contr. for 9 mi. of macad. rd.. in Morgan Co., at $31,100.

Ark., McGhee—Contracts for 165 mi. Ark.-La. Hwy., awarded by Comrs. as follows: Lincoln Co. macad., Realy Constr. Co., Denison, Tex., at $216,130; Drew Co., asph. on conc. base, Metropolitan Constr. Co., $933,958; Chicot Co., asph. on conc. base, Bryant Constr. Co., Waterloo, Ia., $1,177,700; Ashley Co., gravel, Burke Constr. Co., Fort Smith, Ark., $275,979.

Cal., Eureka—Mercer-Fraser Co. awarded contr. for grading 6½ mi. on Eureka-Arcadia sec. of Hwy., at $48,500.

Cal., Lodi—Clark & Henery Constr. Co., Stockton, awarded contr. for paving North School St., Elm St. to City limits, at abt. $25,000.

Cal., Los Angeles—John Hayes, City, awarded contr. for constr. of Second St. tunnel and regrading and repaving adjacent streets, at $905,773. Work calls for following quantities, irrespective of street work: 109,670 cu. yds. conc., 17,003 cu. yds. brk. arch, 126,000 sq. ft steel reinforc., 9,750 sq. ft. curb, 1,502 lin. ft. bithu. pavement, etc.

Cal., Los Angeles—Geo. R. Curtis, 2440 E. 26th St., City, awarded contr. for grading and paving 8th St., Fedora to Hobart Blvd., at $10,000.

Cal., Sacramento—Federal Construction Co., Call Bldg., San Francisco, awarded contr. for grading and paving with conc. abt. 6.7 mi. state hwy., Santa Cruz Co., at $48,530.

Cal., San Diego—Gilmore-Wilton Co., Pacific Elec. Bldg., Los Angeles, awarded contr. for paving Laurel St. and San Marcos and Capital Aves., at $13,238.

Cal., San Diego—Theo. Breitenstein, local, awarded contr. for conc. paving on Prospect St., La Jolla, at $3,500.

Cal., San Francisco—W. P. Holland, 701 De Haro St., awarded contr. by Wells-Fargo Co. for grading Folsom and Hawthorne Sts., at $22,000.

Cal., Santa Cruz—B. Byrne, local, was awarded contr. for curbing, paving, culverts, etc., on Ocean View Ave., at $9,752.

Fla., Bradentown—Finley Method Co., Houston, awarded contr. by Manatee Co. Comrs., to construct 17,000 sq. yds. penetration macad. surf. on Fruitville Rd., at $12,600.

Fla., Dade City—Jas. W. Keggin, Arcadia, awarded contr. by City, to construct 4,300 yds. sheet asph. paving, 3,200 lin. ft. curbing, at abt. $15,000.

Fla., Miami—Seminole Constr. Co., City, awarded contr. for construct'g Tiger Tail Rd., at $5,086.

Ga., Atlanta—Pittman Construction Co., Rhodes Bldg., awarded contr. for paving with conc. approx. 12,670 sq. yds. on North Ave., at $2.14 per sq. yd.

Ga., Atlanta—Jamison & Hallowell, Montgomery, Ala., awarded contr. by Fulton Co. Comrs. to pave Peachtree Rd., 4 secs., 15,000 yds. each, conc. base, bithu. surf., at $200,000.

Ga., Augusta—Ely Co., local, awarded contr. for paving on Railroad Ave. (asph. conc), at $29,543, also on 15th St. (asph. conc), at $20,088; Lawrence Constr. Co., City, awarded contr. for Walton Way (cem. conc.), at $141,750, also for Central Ave. (cem. conc.), at $285,000.

Ga., Statesboro—J. B. McCrary & Co., Atlanta, awarded contr. for street paving, at about $50,000.

Ill., Freeport—Gund-Graham Contracting Co., City, awarded contr. for brk. street improvement work, at $40,000.

Ill., Great Lakes—Embankment Co., Joliet, awarded contr. for bldg. roads and walks at mechanics' school, at $19,740.

Ill., Levington—Roy L. Williams, Cairo, Ill., awarded contr. for paving State, Broadway and County Sts., at abt. $70,000.

Ill., Waukegan—Jas. Cape & Sons Co., Racine, awarded contrs. for brick paving at $40,000.

Ind., Goshen—Cripe & Seaman, City, awarded contr. for paving unfinished portion of Goshen-Middlebury rd., with brick, at $16,728.

Ind., Goshen—Northern Constr. Co., Elkhart, awarded contr. for conc. rd. in Concord Twp., at $5,750.

Ind., Indianapolis—Marion Co. Constr. awarded contr. by Co. Comrs. for improving Pendleton Pike, 38th to Lawrence and from Lawrence to Ft. Harrison, at $41,029.

Ind., Indianapolis—Marion Co. Constr. Co., 1600 S. West St., awarded contract for install'g asph. conc. paving on 54th St., at $152,000.

Ind., Kentland—Atkinson & Goodard, local, awarded contr. for 1.75 mi. macadam rd., Beaver Twp., at $8,950.

Ind., Kokomo—L. M. Turley, Galveston, awarded contr. for 13,207 ft. gravel rd. in Clay Twp., at $9,787.

Ind., Laporte—Wm. D. Smith & Co., City, awarded contr. for Aug. Schirr Rd., New Durham Twp., at $12,375; Jacob Ackerman awarded contracts for H. H. Rosenbaum Rd., Cass Twp., and Albert G. Rosenbaum Rd., Hanna Twp., at $6,440 and $14,000, respectively.

Ind., Muncie—Curtis V. Rector awarded contr. for constr. of Samuel A. Sedan Rd., in Harrison, Hamilton and Center Twps., at $1,400; Gates & Hamilton awarded contr. for Harry Whitney Rd., Perry Twp., at $6,800; Harshman & Jarrell awarded contr. for O. C. Wellington Rd., Mt. Pleasant Twp., at $8,720.

Ind., Logansport—J. C. O'Connor & Son, Delphi, awarded contr. for constr. of stone rd. in Tipton Twp., Cass Co., at $15,989.

Ind., Noblesville—W. W. Michael, Anderson, awarded contr. for constructing Hamilton Co. Rd., at $7,485.

Ind., Peru—Ray N. Sullivan, local, was awarded contr. for 2 gravel rds. in Miami Co., at $8,475.

Ind., Rushville—Moore & Christ Constr. Co., Letts, awarded contr. for 13,045 ft. crushed stone rd., Walker Twp., Rush Co., at $22,700.

Ind., South Bend—H. W. Reed & Sons Constr. Co., Wishawaka, awarded contr. for construct'g three gravel rds. in Penn Twp., at $27,500, $12,100 and $19,600, respectively.

Ind., Wabash—Wm. C. Menuly, local, was awarded contr. for bldg. Marion Reed Rd., at $34,973.

Ind., Winamac—O. L. Markle, Winamac, awarded contr. by Pulaski Co. for grading and graveling 2 mi. F. A. Ogle Rd., at $11,888.

Ia., Cresco—Frank B. Richardson, Maxwell, awarded contr. for abt. 33,000 cu yds. grading in Howard Co., at 35c per cu. yd.

Ia., Davenport—G. A. Carlson, 803 E. Euclid St., Spokane, Wash., awarded contract for bldg. perm. hwys. Nos. 1-C and 4, at $34,000.

Ia., Fort Dodge—Aug. Black & Andrew Mallinger, Duncome, Ia., awarded contr. by Webster Co. for grading and gravel'g rds., at $40,000.

Ia., Ottumwa—Wapello Sand & Bldg. Material Co., local, awarded contr. for grading, at $18,000.

Ia., Waterloo—Bryant Paving Co., City, awarded contr. for improving 1-60 mile of road betw. Little Rock and Louisiana state line, at $1,121,000. This is one of the

KOLESCH SURVEYING INSTRUMENTS FOR SERVICE

Try out a KOLESCH Instrument on your work—at our expense

We will gladly send municipal engineers our instrument to test without any obligation to purchase until it has proved its worth. **Kolesch** Transits and Levels are sturdy, accurate and moderate in price. Every detail has been studied to give an instrument that can be counted on for unvarying reliability and long life.

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The Spirit of War Service

Alone in the midst of war's desolation, the telephone lineman crawls to mend the broken wires.

On all sides the thunder of artillery; in the air bursting shrapnel.

He faces danger with that unconquerable spirit of war service which permits him to think only of maintaining the telephone connections.

The safety of the troops depends on these lines of communication, often used for the sentries' warnings, the carrying of official commands and the summoning of reinforcements.

In a dark hole hidden among sparse brushwood are the telephone operators, some of whom have been for months in their damp cave ceaselessly swept by shells.

And they are admirable, all these heroes of the Signal Corps, whether serving in darkness or in the all too bright light of day.

The spirit of war service, over here as well as over there, furnishes the nerves, the endurance, the morale—the stuff that wins war.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

largest road contracts ever awarded; 168 miles will be paved on this highway.

Ia., Waterloo—Allison Fulton, local, was awarded contr. for construction of improved rd. in Grant Twp. and Waterloo, known as D. L. Leas Rd., at $55,200.

La., Oberlin—Smith Bros., Crockett, Tex., awarded contrt. by Allen Parish to construct roads, at $75,000.

Md., Baltimore—W. C. Evans, City, was awarded contr. for paving several alleys, at $38,000.

Md., Baltimore—H. C. Firor, City, was awarded contr. for grading and excavating parkway betw. Rosedale and Poplar Grove Sts., at 53c per cu. yd, or a total of about $39,750.

Md., Baltimore—Baltimore Asph. Blk & Tile Co., 231 Courtland St., City, awarded contr. for asph. paving on several streets, at $121,150.

Mich., Albion—Bishop & Ralston, Hillsdale, awarded contr. for bldg. 7 mi. of rd. connecting Tekonsha and Marshall, at $35,388.

Mich., Marshall—Mitchell & Drake, Battle Crk., awarded contr. for 4.5 mi. of rd. in Leroy Twp., at $22,000.

Mich., Mt. Clemens—Detroit Asph. Co., 20 McGraw Bldg., Detroit, awarded contr. for paving 3.4 miles of road, at $100,447. Comn., to construct new lake shore rd., 10 miles, conc., at $236,393.

Minn., Duluth—Victor Constr. Co. was awarded contr. for county rd. work at $5,366 and $9,924.

Minn., Elk River—Petrie, Colburn & Merrill, Anoka, awarded contr. for bldg. hwy. between Zimmerman and Princeton, at $23,000.

Minn., Stillwater—S. J. Grove & Sons, Minneapolis, awarded contr. by Pine Co., to regrade and gravel 20 mi. of state rd. betw. Pine City and Sandstone, at $37,182.

Miss., Hazlehurst—J. R. Parker, Crystal Springs, awarded contr. by Copiah Co. Comrs. for 15 to 20 mi. surface roads; $50,000 available.

Mo., Cape Girardeau—J. H. Rocoso, local, awarded contr. to pave Normal St., Pacific to Henderson Sts., at $9,108.

Mo., Independence—W. A. Ross, Kans. City, awarded contr. by Jackson Co. Comrs. to grade 4½ mi. of road, Holmes St. and city limits to Red Bridge Rd., at $28,428.

Mo., Joplin—Sherwood-Myers-O'Day Co., local, awarded contr. for bldg. concrete hwy., Webb City to Missouri-Kansas state line through Joplin, at $107,556.

Mo., St. Louis—Eyerman Constr. Co., 1216 S. Grand St., awarded contr. for paving Neosho and Compton Sts., at $27,285; Bitum. Paving Co., Railway Exch., contr. for Queens St., at $20,524.

Mo., St. Louis—Bd. Pub. Service awarded contracts as follows: O'Fallon St., to Perkinson Bros. Constr. Co., at $79,286; Taylor St., to Skrainka Constr. Co., at $11,005; Penroke St., to Perkinson Bros. Constr. Co., at $7,790; Osceola St., to Webb-Kunze Constr. Co., at $7,685. All of St. Louis.

N. J., Freehold—Wm. P. McDonald Constr. Co., Mt. Vernon, N. Y., awarded contract at $57,346, and Standard Bithu. Co., 50 Church St., N. Y. City, contr. at $74,935, for sheet asph. pavement on macad. base on 1¼ mi. Norwood Ave., Long Branch, from the fountain to Cedar Ave.

N. J., Jersey City—Clinton Constr. Co., 306 Charles St., W. Hoboken, awarded contract by city for paving Palisade Ave., at $64,125, 22,500 sq. yds. asph. on present blk. pavement 40 ft. wide; W. T. S. Critchfield, Green St., awarded contr. for repairing all asph. pavements in city not under contr., to Nov. 30, 1918, at $46,500.

N. J., Red Bank—Wm. P. McDonald Constr. Co., Mt. Vernon, N. Y., awarded contract for laying asph. pavement on Norwood Ave., Long Branch, at $57,346.

N. J., Mt. Holly—Utility Constr. Co., New Brunswick, awarded contr. to build second section of conc. road from Pemberton to the Government reservation boundary near Lewiston, at $49,005.

N. Y., N. Y.—Hudson View Constr. Co., 700 Riverside Dr., awarded contr. by F. L. Dowling, Pres. Boro, for regrading and grading Service St., near Riverside Dr., at $75,000.

N. Y., Buffalo—German Rock Asph. Co., Inc., City, awarded contr. for asph. paving on conc. fnd., on Spencer St., at $7,320.

N. C., Rutherfordton—Citizens Brk and Tile Co., City, awarded contr. for surfacing National Hwy., at $16,850.

N. D., Fargo—Treadwell-Twichell, Mapleton, awarded contr. for 45 miles road grading at $19,210. W. R. Tucker, Co. Aud.

O., Cincinnati—Kirchner Constr. Co. awarded contr. for improving intersection of Myrtle Ave. and Alms Pl., at $5,501; Henkel & Sullivan, City, awarded contr. for improv'g Pike St., at $11,694.

O., Cleveland—Enterprise Paving and Constr. Co. only bidders for paving Windfall Rd., at $49,000.

O., Cleveland—Trinidad Paving Co., Arcade Bldg., awarded contr. by City for paving West Blvd., Madison to Lorain Aves., bithu. on conc. base, 5,000 ft. long, at $67,721.

O., Columbus—C. W. Ryan, Maumee, O., awarded contr. for improvt. of 3.67 mi. of Columbus-Millersburg Rd., Holmes Co., at $40,669. L. C. Herrick, Norwalk, awarded contr. for paving 13 mi. of Cleveland-Buffalo Rd., in Lake County, at $364,366.

O., Columbus—W. Neilson, 3026 N. High St., City, awarded contr. for grading in Jefferson Co., at $7,081; Harry Stredbeck, Middletown, O., awarded contr. for grading and paving in Ashland Co., at $120,000 and $70,000, respectively.

O., Lima—L. W. Russell, W. Austintown, awarded contr. for grading highway from N. Lima to Columbia Co. line, at $22,850. Approx. 3½ miles.

O., Mansfield—Geo. Herring & Son, awarded contr. for constr. of lower Lucas Road, at $18,000.

O., Ravenna—Seipel & Wolf, awarded contr. by Portage Co. Comrs. for bldg. Aurora-Warren Rd.,—5.66 mi.—at $95,292; W. J. Wright Constr. Co., awarded contr. for constr. of Atwater-Lunaville Rd., at $33,229.

O., Zanesville—R. C. Burton, local, awarded contrs. for brk. paving on rolled fdn. on 13.63 mi. Natl. Rd., Muskingum Co., at $556,990.

Ore., Coquille—Dyer & Plymale, Bandon, awarded contr. to gravel Bandon-Curry county road (11 miles) at $49,416.

Ore., Heppner—J. Welton, Portland, awarded contr. for improvt. of certain streets, at $19,000.

Ore., St. Helens—Hehart & Mills, local, awarded contr. for constructing 2 mi. St. Helens-Nehalem Rd., at $15,290; J. B. Handley, contr. for Beaver slough crossing, at $5,200.

Ore., The Dalles—Dahl & Dahl, Tygh Valley, awarded contr. for constr. of Dal-

"They covered from 60 to 70 miles per day (on a 15-gallon consumption), hauling three 1-yard batch cars and dropping them at concrete forms at a speed of eight miles per hour."

BELL Oil-Burning Locomotives (kerosene, fuel, oil, distillate or crude oil), possessing 50 per cent greater tractive effort than direct connected locomotives of equal weight, give the *longest possible mileage at the lowest cost per mile.*

BELL Oil-Burning Locomotives (one-man operated and one valve fire control) require no hand-oiling and are Simple and Sturdy in construction throughout. Low in first cost and inexpensive in operation.

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BELL LOCOMOTIVE WORKS, Inc.

30 Church Street (Founded 1908) **NEW YORK CITY**

las-California hwy., betw. The Dalles & Dufur, at $28,000.

Pa., Harrisburg—Frank L. Cohen, Buffalo, N. Y., awarded contr. for constr. of sec. of State Hwy. Route No. 75, Center Twp., Butler Co., at $122,656.

Pa., Harrisburg—Juniata Co., Philadelphia, awarded contr. for improvt. work in Oxford Boro., at $16,444; Kennett Sq. project, awarded to B. F. Wickersham, at $22,287; Summit Constr. Co., Akron, O., awarded contr. for sec. of rd. Greene Twp., Erie Co., at $90,368; McInerney & McNeal, Easton, awarded contr. for sec. of hwy. in Wilson Twp., Northampton Co., at $22,870.

Pa., Harrisburg—Following contracts awarded by State Hwy. Comm.: Wm. Veltte, Mars, Pa., awarded contr. for 1.50 mi. rein. conc. pavement in Butler Co., at $47,992; Norman J. Boyer, Butler, Pa., 3.69 mi. rein. conc. paving in Butler Co., at $119,895.

Pa., Harrisburg—M. J. Scanlon, City, awarded contr. for bldg. road from Willon Grove to Wampum, at $213,450; Peter Connolly, Elmira, N. Y., awarded contr. for road from Wampum to Beaver county line, at $123,617.

Pa., Harrisburgh—Following contracts let by State Hwy. Department: R. I. Taylor, Bellefontaine, for contr. of 0.46 mi. vitr. blk. pavement Bellefonte Boro., at $26,885; Geo. H. Hardner, Allentown, for reconstr. of section of State Hwy. Route 159, at $72,815; C. S. King & W. E. Mangold, Port Allegheny, for grading and draining 1.27 mi. State Hwy. Route 96, McKean Co., at $16,-469; Irving S. Harton, Reading, for 0.86 mi. 2-course macad., Huntingdon Co., at $15,062, and 5.19 mi. 2-course waterbound macad., same Co., Lincoln Twp., at $77,-340; B. G. Coon Constr. Co., Luzerne, for 1.15 mi. rein.-conc. constr. in Montroe Boro., Susquehanna Co., at $38,250, and 1.23 mi. rein.-conc. constr., New Milford Boro., same Co., at $30,145.

Pa., New Castle—New Amsterdam Bonding Co., Baltimore, Md., awarded contr. for bldg. 5¾ mi. highway, rein.-conc.—New Wilmington to New Amsterdam—at $161,-606.

Pa., Philadelphia—Eastern Paving Co., and Union Paving Co., award. contracts for making repairs to asph. throughout city, at $175,000 each.

Pa., Pittsburgh—Austin & Matthews, Westview, awarded contr. for 4.5 mi. Perry Hwy., rein.-conc., in Allegheny Co., at $158,213.

S. C., Gaffney—C. C. Jordon, Wadesboro, N. C., awarded contr. for 8 to 10 mi. of road, clay-gravel, sand-clay and top soil, at $25,000.

Tenn., Columbia—Thompson, Graham & Co., Nashville, awarded contr. for 26,000 sq. yds. asph. conc. pavement, at abt. $30,000.

Tex., El Paso—El Paso Bitu. Co., awarded contr. to reconstruct upper valley rd—3.4 mi., at abt. $35,000.

Tex., Ft. Worth—W. E. Callahan Constr. Co., Dallas, awarded contr. for constructg. south side Arlington Heights Blvd.—2½ miles at 24c per sq. yd. (32,000 sq. yds.).

Tex., Giddings—Smith Bros., Crockett, Tex., awarded contr. for road work in Lee Co., at $150,000.

Tex., Houston—Horton & Horton, City, awarded contr. by Harris Co. Comrs. to contsruct 3.4 mi. conc. paving, at $127,000.

Tex., Wichita Falls—Norwalk Constr. Co., Sherman, awarded contr. for gravel rds., at abt. $9,000 per mi.

Va., Arlington—J. M. Johnston, Arlington, awarded contr. by Cantonment Div., War Dept., Washington, to repair Georgetown and Alexandria turnpike and roadway to Arlington National Cemetery, at $10,000.

Va., Camp Humphries—Cranford Paving Co., 2620 East St., N. W., Washington, D. C., awarded contract for roads around camp by Cantonment Div., War Dept., at $1,250,000.

Wash., Buckley—F. L. Sheldon, local, awarded contr. for construct'g. Buckle Rd., with 1-course conc., at $18,000; also Orting Rd., at $33,750.

Wash., Colfax—G. J. Strickler, Spokane, awarded contr. for 8.75 mi. Inland Empire Hwy., at abt. $58,000.

Wash., Davenport—G. A. Carlson, 803 E. Euclid St., Spokane, awarded contr. for bldg. perm. hwys. Nos. 1-c and 4, at $34,000.

Wash., Olympia—Jas. C. Hendricks, Mossy Rock, awarded contr. for improvt. of 4 miles of National Park hwy., at $21,-633.

Wash., Seattle—Davenport & Picken, Omak and Tonasket, Wash., awarded contracts for constr. of perm. hwy., No. 1-A, at $18,700 and No. 4-A, at $13,300.

Wash., Spokane—J. I. Daniel, City, and Samuel A. Eslick, City, awarded contract for grading and graveling Wells Rd., at Cheney, at $43,377.

Wash., Tacoma—Independent Asphalt Co., awarded contr. for paving 11th St.—Milwaukee viaduct to entrance of Todd & Foundation shipyards—at $32,750.

Wash., Tacoma—F. L. Sheldon, City, awarded contr. for constructing 2 mi. of road near Orting, at $33,750.

Wash., Walla Walla—L. Lanning, local, awarded contr. by Walla Walla Co., Comrs. for completion of 5.45 acres of rd. near Wallula, at $15,474.

W. Va., Charleston—Reed & Lapsey, S. Charleston, awarded contract for extensive work by Baker-Myers Realty Co., through M. W. Venable Engr'g. Co. Work includes, besides paving, laying of sewer, water and gas mains, sidewalk construction and laying of curbs. Est. cost, $120,000.

W. Va., Hamlin—Hager & Hager, Midkiff, W. Va., award. contr. by Lincoln Co. to constr. 2 mi. of rd.; Adkins & Chapman, Smith, W. Va., contr. for 8,000 ft.; Wentz Constr. Co., Huntington, W. Va., 2½ miles; further constr. towards Ranger by force acct. This is portion of 82-mi. rd. grading and construction for which $675,000 bonds were voted.

W. Va., Huntington—Amos Trainer, local, awarded contr. for abt. 4,668 sq. yds. pavement, at $14,000.

W. Va., Kingwood—Spindler Kingwood, local, awarded contr. by Preston Co. Commrs., at $160,000 and $250,000 to construct asph. rd. in Kingwood Distr., and conc. rd. in Portland Distr.

Wis., Milwaukee—Milwaukee Constr Co., awarded contr. for paving alleys between W. Water and Second Sts., and Claybourn and Fowler Sts., stone blk., at $5,945; also alley betw. 17th and 18th Sts., and Prairie and Chestnut Sts., conc., at $2,312; Wisconsin Constr. Co., contr. for bitum. conc. on 12th Ave., bitum. conc., at $10,054; John Weiher, stone blk., on Cold Spring Ave.—10th to 11th Sts., at $5,200.

Wis., Milwaukee—Following 9 contracts awarded by Pub. Wks. Department: Bitum. conc., 28th St., to Jno. S. O'Neil, at $7,258; Rush Ave., to Frank W. Blodgett, $8,250; Barrell St., to H. B. Clayton, at $1,449; asphalt, 12th Ave., White Constr. Co., $2,664; 24th Ave., Badger Constr. Co., at $8,394; Dakota St., White Constr. Co., at $26,396; North Ave., F. P. Coughlin Co., at $44,452; 25th St., Badger Constr. Co., at $27,987; 16th St., Badger Constr. Co., at $18,760.

Wis., Superior—John Differ, awarded contr. for conc. paving on Lamborn Ave. — ft. of North 3rd St., to Main St.—at $16,174; also for concrete paving on Main St.—Lamborn Ave., to Interstate Brdg., at $24,848.

Wis., Stevens Point—Murphy Constr. Co., Manitowoc, awarded contr. for paving abt. 2 mi., at $38,000.

Wyo., Casper—Warren Constr. Co., Journal Bldg., Portland, Ore., awarded contr. for paving in Dist. No. 4—4. in base at $94,631; 5. in. base, at $98,061.

USE TRUCKS!

The followig announcement was authorized last week by the Council of National Defense:

The Council of National Defense has given its formal approval to all measures designed to facilitate the use of the motor truck in transportation wherever it can be utilized. Its efforts in this connection have been directed through the highways transport committee. Through the state councils of defense and other agencies it is urging all communities, as far as possible, to adopt the motor truck to their local needs and encourage its use in any way to help existing transportation problems. The truck is proving of a great deal of service in many districts in relieving congestion in freight terminals. The council has just passed the following resolution:

"Resolved, That the Council of National Defense approves the widest possible use of the motor truck as a transportation agency, and requests the state councils of defense and other state authorities to take all necessary steps to facilitate such means of transportation, removing any regulations that tend to restrict and discourage such use."

SEWERAGE AND SEWAGE TREATMENT

Ariz., Jerome—Wm. B. Arndt & Merkle, P. O. Box 655, City, awarded contr. for constructing sewer sys. and treat. tank, at $32,296.

Cal., Calexico—Bush Constr. Co., local, has been sub-let contr., by G. R. Daley, local, for constr. of san. sewers, at abt. $18,000.

Cal., Long Beach—J. Wost, 2152 Reservoir St., Los Angeles, awarded contr. for bldg. 27,500 lin. ft. cem. pipe sewers, etc., in Sew. Dist. No. 7, at $31,487.

Cal., Los Angeles—S. Zarubica, 3006 6th Ave., City, awarded contr. for bldg. 7,898 lin. ft. 8-in. vitr. pipe sewer, 14 manholes, 4 drop holes and 8 flush tanks, at $11,700.

Cal., San Diego—Olof Nelson, 1470 E St., San Diego, awarded contr. for constr. of 1,620 lin. ft. 6-in. chem. pipe sewer in portion of Frary Heights, at $2,479.

Cal., Santa Barbara—Wm. Ledbetter, Pacific Elec. Bldg., Los Angeles, awarded contr. for constr. of sewage disposal plant here, at $31,945.

Cal., Stockton—F. C. McIntire, 406 N. Aurora St., awarded contr. by City for bldg. 24 in. rein.-conc. sewer from north disp. plant to San Joaquin River, at abt. $13,092.

Idaho, Rupert—B. M. Barsden & Co., Butte, awarded contr. for sewer constr. in Dist. No. 1, at $82,000.

Ia., Victor—Comstock & Hanson, Cedar Rapids, awarded contr. for furnishing and laying 16,507 ft. sewer pipe, 8 to 12 in., and 37 manholes and 8 flush tanks, at $13,560.

Kans., Salina—Snyder Morton, local, awarded contr. for extending sewage system 8,000 ft. east, at $30,000.

Ky., Louisville—Following contracts awarded by Sewer Board: Penn. Ave. sewer, Henry Bickel Co., $16,089; in 23rd St., in Greenwood Ave., and in 22nd St., to J. H. Cahill, $8,229; in 27th St., K. A. Barker, $3,078; alley north of Madison St., K. A. Barker, $4,356; alley betw. Mary and Catherine Sts., K. A. Barker, $3,499.

La., Shreveport—R. N. McKeller, City, awarded contr. to build sewer in Taylor St., at $14,079.

Minn., Madison—Christ Nielsen, Wells Minn., awarded contr. for furnishing and laying abt. 40,200 ft. 6-in. to 8-in. tile, at $12,650.

Minn., Butterfield—W. B. Carter, Sioux City, Ia., awarded contr. for constructing sewer sys., at $28,096.

Mich., Detroit—Worswich Bros., local, awarded contr. for constructing sections 1 and 2, Lonyo Rd. sewer, at $1,122,754.

Mo., Kans. City—T. M. Torson & Sons, Kans. City, Kans., low bidder for bldg. third sec. of Town Fork sewer, at $65,754.

Mont., Big Timber—Gust. Nordquist, local, awarded contr. for construction of sewer sys., at $39,298.

Mont., Poplar—C. H. Kelley, Kalispell, awarded contr. for constr. of sewer sys., at $54,131.

N. J., Newark—Merritt-Chapman Wrecking Co., awarded contr. to furnish New York bay sec. Passaic Valley sewer, at $300,000.

N. J., Plainfield—C. R. Simpson, 90 West St., N. Y. City, awarded contr. for improving sewerage disp. plant, at $30,386.

N. J., Washington—Suburban Eng. Co., 15 West 38th St., New York City, awarded contr. for enlarging sewage disp. plant, including addn. septic tank; also enlarging sludge beds, at $10,956.

N. M., Las Vegas—R. S. Fisher, local, awarded contr. for bldg sewer sys., at abt. $24,737.

N. Y., Rochester—Whitmore, Rauber & Vicinus, awarded contr. for installing sewer in Blossom rd., at $5,340.

O., Cincinnati—Jones & Crumley, City, awarded contr. for laying of Norwood sec.

of 36-in. low service, loop water main, at $49,189; Jas. J. Brown, local, contr. for sewering California Ave.—Reading rd. eastwardly 250 ft., at $2,130; Gradison Constr. Co., for improving Cosby St.—Spring Grove to Hamilton Ave., at $1,409.

O., Cleveland—J. Duff Constr. Co., 603 Marshall Bldg., awarded contr. for bldg. vitr. sewer in Archwood Ave., and W. 36th St., at $31,519.

Okla., Commerce—James Constr. Co., Guthrie, awarded contr. to construct 30,000 lin. ft. 15, 12, 10 and 8-in. vitr. sewers, at $21,797.

S. D., Watertown—Watertown Tile & Constr Co., local, awarded contr. for drainage propositions in Henry, at $4,250.

Tex., Dallas—Vibrolithic Co., Dallas, awarded contr. to construct Colonial Ave. Dist. storm sewer, at $17,741.

Wash., Seattle—Super Constr. Co., 131 Nob Hill Ave., City, awarded contr. for bldg. clay pipe sewer in 22nd Ave., S. W., and various other streets, at $69,825.

W. Va., Charleston—Reed & Lapsey, So. Charleston, awarded contr. for trunk line sewer extending 2,000 ft. from E. Crawford City down into Govt. property at Nitro, to point below Lock No. 7. Work is in connection with other improvts. being made by Baker-Myer Realty Co. Est. cost, $115,000.

Wis., Kenosha—E. H. Prange, Grand Rapids, awarded contr. for installing trunk sewers, at $80,733.

Wis., Kenosha—P. Frandsen, Kenosha, awarded contr. for constructing sewers, at $2,265.

Wis., Marinette—J. J. Conway Co., St. Paul, awarded contr. by Village of Niagara, for constructing new sewerage and waterwks. sys., at $49,000—sewerage sys. to cost $17,000; waterwks., $22,000.

Wis., Milwaukee—Herman Hohensee, City, awarded contr. for constructing 72-in. intersect'g. sewer—8th and Sycamore to 6th, and on 6th to Clybourn St., at $60,912.

Wis., Milwaukee—Geo. E. Zimmerman, City, awarded contr. for high level intercept'g. sewer, at about $250,000.

Wis., Sun Prairie—Mierswa Constr. Co., 1517 Oregon St., Oshkosh, awarded contr. for constr. of sewer sys., and disp. plant, at $32,804.

Wis., Union Grove—F. E. Kaminski, Watertown, low bidder for construct'g. sewers in Main St., at $6,925.

Wis., W. Allis—Kroening Constr. Co., 708 Majestic Bldg., awarded contr. for constr. of addn. to east side sewage disp. plant, at $39,200.

WATER SUPPLY AND PURIFICATION

Cal., Filmore—Thos. Haverty Co., 517 S. Los Angeles St., Los Angeles, awarded contr. for construct'g. distributing sys. for municipal water plant, at $25,794; Paul Ehlers, 5618 Harold Way, Los Angeles, awarded contr. for construct'g. circular rein.-conc. reservoir, at $12,000, and for constr. pump pit and pump house, at $1,800; Newton Palm, local, awarded contr. for drilling well, at $3,619.

Cal., Huntington Park—Clarence Whipple, local, awarded contr. for construction of circular rein.-conc. reservoir, 188 ft. in diameter and 12 ft. deep, at Puente, for La Puente Co-operative Water Co., at $8,532.

Cal., Orange—Frank W. Dimmock, Santa Ana, awarded contr. for drilling well for city water sys., at $5,161.

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For full information, Address "Return Loads" Bureau, care Municipal Engineering, 538 S. Clark St., CHICAGO.

Cal., Pomona—Gimmel and Roseberry, local, awarded contr. to build a 500,000-gal. conc. reservoir at north end of College Ave., in Claremont, for Valley Water Co.

Cal., Riverside—Western Rein.-Conc. Pipe Co., 1611 E. 6th St., City, awarded contr. for bldg. 4,600 ft. 36-in. rein.-conc. pipe and changing location of 3,000 ft. riveted steel pipe, at about $26,500.

Cal., San Bernardino—Amer. Pump Co., 420 E. 3rd Ct., City, awarded contr. for pumping equipment, at $4,196.

Cal., San Francisco—Worthington Co., Inc., Sharon Bldg., City, awarded contr. for furnishing and delivering air compressors for Mtn. Div., Hetch Hetchy Aqueduct, at $24,142.

Cal., Santa Barbara—Redwood Mfg. Co., Pittsburg, Cal., awarded contr. for 13,000 lin. ft. 18 and 10-in. redwood pipe to divert water from Sheffield reservoir to Mission reservoir, at $14,028.

Cal., San Rafael—Bent Bros., Central Bldg., Los Angeles, awarded contr. by Marin Municip. Water Dist. for bldg. main pipe line (conc.) at about $182,000.

Cal., Sierra Madre—Byron-Jackson Iron Wks., 352 Market St., San Francisco, awarded contr. for install'g. pumping equipment in city well No. 2, at $6,399.

Fla., Brooksville—J. B. McCrary Co., 3rd Natl. Bank Bldg., Atlanta, Ga., awarded contr. by City for waterworks to have daily cap'y. 260,000 gals., at about $20,000.

Ind., Hammond—Chicago Bridge & Iron Works, 37 W. Van Buren St., Chicago, awarded contr. for bldg. water tank and tower, at $5,000.

Ind., Indian Creek—Rust Engineering Co., Penn Bldg., Phila., Pa., awarded contr. for construct'g. pumping sta., including 1-story, 37x71 ft. power plant, conc., hollow tile and stucco constr., at approx. $35,000.

Ia., Davenport—Ryan Plumbing Co., Davenport, awarded contr. for water and sewer services during 1918.

Ia., Greenfield—Peter N. Kruse, Spencer, awarded contr. for water mains and transmission line, at $13,000.

Kans., Eureka—J. S. Davis, Eureka, awarded contr. for improving water sys., at $12,263.

Ky., Louisville—Allis-Chalmers Co., W. Allis, Wis., awarded contr. by Louisville Water Co., for 30,000,000-gal. pumping engine, to be installed in plant to supply Camp Taylor with water, at about $350,000.

Md., Crownsville—D. C. MacAleer Constr. Co., 15 E. Fayette St., Baltimore, awarded contr. for bldg. filtration plant at Crownsville State Hosp., at $7,000.

Mass., Boston—Thomas Burke, City, awarded contract for installing service pipes, establishing branches, hydrants, gates, replacing boxes, etc., at $15,880.

Mich., Flint—DoLaval Steam Turbine Co., Trenton, N. J., awarded contr. for furnishing and installing 15,000,000-gal. 150 ft. total head geared turb. driven centrif. pumping unit with condenser and auxiliaries, at $30,200.

Neb., Fremont—Wright Elec. Co., local, awarded contr. for pump for waterwks. sys., at $8,700.

Neb., Sidney—O'Fallon Supply Co., 1625 15th St., Denver, awarded contr. for installing machinery in water and elec. light and power plants, at $30,592.

N. J., Elizabethtown—Roberts Filter Mfg. Co., 949 Bway., awarded contr. by Elizabethtown Water Co., 68 Broad St., for bldg. rapid sand filtr. plant and pumping station.

N. Y., N. Y.—Sprague & Henwood, Inc., Monsey and New York Sts., Scranton, Pa., awarded contr. by Bd. Water Supply, for making, testing and cleaning borings around shafts of city tunnel Catskill Aqueduct, at $24,800.

N. Y., Olean—Hydro Constr. Co., Buffalo, awarded contr. for construct'g. filter plant including pump house, pipe line, filt. beds, conc.-sediment basin and installing pumping engine, at $55,000.

N. Y., Phoenix—Chas. R. Lewis, Ilion, N. Y., awarded contr. for constr. of water sys., at $6,496.

N. Y., Poughkeepsie—Hembdt, Helling & Bishop, Monticello, N. Y., awarded contr. for construct'g. water supply sys., at Hudson River State Hosp., at $38,500.

N. D., Grafton—Wollman Lbr. & Conc. Co., City, awarded contr. for dam, at $2,885.

O., Covington—Stacey Mfg. Co., Cleveland, awarded contr. by Eagle Cordage Co., for bldg. water tower 131 ft. high, 20 ft. circumference, at abt. $5,000.

Okla., Okmulgee—Burns & McDonnell, 400 Interstate Bldg., Kans. City, Mo., awarded contr. for bldg. water supply and sewerage sys., at $24,000.

Ore., Arlington—Hedges & Hule, The Dalles, awarded contr. for bldg. pipe line and 350,000-gal. reservoir.

S. D., Beresford—J. Neween & Co., City, awarded contr. for extending water sys., involv'g. deep well and addn. to pump sta., at $25,012.

Wash., Bellingham—2,000 ft. conc. pipe, 48-in. diam. will replace 2,000 ft. 24-in. sheet steel water main. Est. cost, abt. $50,000. Work by day labor.

Wash., Puget Sound—W. H. Mitchell, local, awarded contr. for supply connect. here, at $23,900.

Wis., Marinette—J. J. Conway Co., St. Paul, awarded contr. for construction of waterworks in Village of Niagara, at $22,000.

Wyo., Rawlins—L. B. Hebbergall, Medicine Bow, awarded contr. for drilling and casing well. at $3,600.

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BRIDGES AND BUILDINGS

D. C., Washington—Lower & Reed, Charlotte, awarded contr. for bldg. brdg. across Tenn. river at Sheffield, Ala., at $200,000.

Cal., Los Angeles—Jno. Hayes, City, awarded contr. for bldg. Second St. tunnel; also boring and lining tunnel, at $946,000.

Cal., San Francisco—Ralston Iron Wks., City, awarded contr. for steel frame of viaduct from north side of main entrance to Ferry Bldg., across the Embarcadero, to intersec. with north side of Market St., at $19,865.

Fla., Miami—Geo. O. Reed, Michigan City, Ind., awarded contr. at $79,500, by Dade Co. Comrs., (Ben Shepard, Clk.), for constr. of 2 bascule bridges over causeway—Miami to Miami Beach. Total cost, $84,500.

Ill., Chicago—Great Lakes Dredge & Dock Co., City, awarded contr. for constructing sub-struc. of double-deck bridge across Chicago River at N. Mich. Ave., just east of Rush St. struct., at $708,699.

Ia., Atlantic—S. K. Anderson, local, awarded contr. for 31 cem. culvts., and 2 cem. bulkheads, at $36,127.

Ia., Marshalltown—A. P. Munson, Marion, awarded contr. for construct'g. 9 brdgs. in northeastern part of county, at $10,700; Cole Bros., Ames, contracts for 16 brdgs., northwestern part, at $16,610; Ingersoll-Stouffer Co., City, contr. for 26 brdgs., southwestern part, at $26,750; A. P. Muncon, 23 brdgs. in southeastern part, at $16,680.

Ind., Ft. Wayne—Herman Tapp, City, awarded contr. for constr. of State St. brdg. in City, at $93,000.

Ind., Richmond—Isaac R. Smith, City, award. contr. for construct'g. several brdgs., at $15,500.

Ia., Burlington—Jno. J. Loftus, Burlington, awarded contr. for riprap, Keithsburg, Ill., to Burlington, at $23,000.

Ia., Dakota City—C. A. Miller, Humboldt, and C. Johnson, Humboldt, awarded contracts for bldg. 37 conc. box culvts., 1 pony truss span, 3 beam spans, and 4 conc. slab spans, at $27,856 and $8,500, respectively.

Ia., Elkader—Rodeis & Bahs, Strawberry Point, awarded contr. for bldg. 287 ft. open spandrel arch and deck girder brdg. with 2,140 ft. steel truss spans and 1 conc. slab span, at $26,805.

Ia., Marengo—Following contracts awarded for county brdg. work for year: Group A, Waterloo Constr. Co., Waterloo, at $6,750; Group B, Milo Burnett, Marengo, at $26,932; Group C, Iowa Brdg. Co., at $7,995; Group D, Ia. Brdg. Co., Des Moines, at $11,629; Group E., Milo Burnett, $26,340; Group F, Fed. Brdg. Co., Des Moines, at $20,750.

Ia., Primghar—Taylor & Anderson, Sioux City, awarded contr. by O'Brien Co., for 6 steel pony truss bridges, 1 steel span and 2 conc. slab brdgs., and 3 conc. box culverts, at $32,490; box culverts to E. Grant, Calumet, at $3,259; 4 conc. slabs and conc. culverts. to G. Garder, Sheldon, at $14,400.

Ia., Toledo—A. P. Mimsen, Marion, awarded contr. by Tamo Co., for bldg. 1 double pony truss brdg., 3 I-beam brdgs., 1 slab brdg. and 8 rein. conc. culvts., at $30,000.

Ia., Traer—A. P. Munson, Marion, awarded contrt. for 180-ft. steel brdg. over Wolf Crk., at $16,500.

Kans., Alma—J. A. Johnson, Junction City, Kans., awarded contr. for brdg. and culverts at Alma, at $11,924.

Me., Mt. Desert—Nelson & Spellman, Bangor, awarded contr. for rein.-conc. hwy. bridge, 642 ft. long with 20 ft. roadway, at abt. $84,000; Boston Bridge Works, Inc., 47 Winter St., Boston, awarded contr. for steel swing draw brdg., 115 ft. long, 20 ft. rdway., at $15,300.

Minn., Breckenridge—Union Dredge Co., Crookston, awarded contr. by Wilkins Co., for bldg. 36 metal culvts., and 24 wooden bridges, at $4,449 and $19,986, respectively.

Minn., Princeton—Minneapolis Bridge Co., 931 McKnight Bldg., Minneapolis, awarded contr. by Millelac Co., for bldg. and repairing bridges and culvts. on Minn. Project No. 3, at $15,800.

Mo., Kans. City—Geo. A. Fuller Constr. Co., Chicago, awarded contr. for completing 23rd St. trafficway viaduct, including 2 rein.-conc. approaches, at approx. $725,000.

Neb., N. Platte—T. Goss, Elm Creek, awarded contr. by Lincoln Co., for bldg. rein.-conc. brdg. with 10 50-ft. conc. arches, conc. piers and abutmts., etc., at $38,245.

N. H., Exeter—Cashman Bros., Newburyport, Mass., awarded contr. for rebldg. Hampton River brdg. This is longest wooden bridge in world, and connects Salisbury and Hampton.

Use Your Influence

"Return Loads" Bureaus!

A Nation-wide movement is on foot for the establishment of Motor Truck Routes between cities, over which freight may be hauled in order to relieve the congestion of railroad freight traffic.

See to it that your Chamber of Commerce and other Civic and Commercial organizations establish a *"Return Loads" Bureau* at once.

Get in touch with the Highway Transport Committee and the Highways Industries Association —Washington, D. C.

The Government hopes that truck routes may be planned generally, and that ***"Return Loads" Bureaus*** may be established in all cities having a population of 30,000 or more.

Your *"Return Loads" Bureau* should gather and keep records of all concerns having goods to be moved to points within 200 miles, recording the weight, complete description, types of packages and other information.

The owner of a truck bringing a load to your city should telephone your ***"Return Loads" Bureau*** and ascertain just where he could obtain a load of freight for the return trip, with all information as to the character of the shipments.

Use Your Influence

N. J., Jersey City—Beth. Steel Brdg Co., Bethlehem, awarded contr. for repairing brdg. over Passaic River on Lincoln Hwy., at $71,400.

N. Y., Albany—Lupfer & Remick, 594 Ellicott Sq., Buffalo, awarded contr. for bldg. truss brdg. over Old Erie Canal at Hertel Ave., at $27,967.

N. D., Grafton—Fargo Brdg. & Iron Co., Fargo, awarded contr. for brdgs. in Walsh Co., at $16,253; Nollman Lbr. & Constr. Co., awarded contr., at $9,484.

O., Lima—Mullen & Blodgett, local, awarded contr. for bldg. Pierce St. bridge, at $38,887; National Concrete Co., Indianapolis, awarded contract for Main St. brdg., at $41,140.

Ore, Dillard—Portland Brdg. Co., Portland, awarded contr. for bldg. brdg. here, Douglas Co., at $18,732.

Ore., Portland—Parker & Banfield, City, awarded contr. for constr. of rein.-conc. brdg. at Hood River, at $53,915.

Pa., Easton—C. P. Bauer, Reading & Philadelphia, (who is constructing huge railroad yds. for Philadelphia & Reading in Lower Saucon Twp., near Hellertown) has been awarded contr. by the Company to erect steel and conc. brdg. across Gichline Lane near new Silvex plant, at $90,000. It will be 46x255 ft. Work will start at once.

S. C., Charleston—Austin Bros., Atlanta, Ga., awarded contr. for constructing steel draw brdg., over Church Crk., at $9,800.

S. C., Spartanburg—Luton Brdg. Co., Knoxville, Tenn., and B. S. Minus, Asheville, awarded contracts to construct 7 brdgs., at $26,931.

Tex., Dallas—Dallas Lime & Gravel Co., awarded contr. for constr. of Lamar Street culvert over Mill Creek, at $41,740.

W. Va., Naugatuck—Vincennes Brdg. Co., Vincennes, awarded contr. for steel brdg. over Pigeon Crk., at $15,000.

W. Va., Romney—Enterprise Brdg. Co., Elkins, awarded contr. for constr. of 200-ft. span conc. brdg. of 3 66-ft. arches over So. Branch of Potomac River here, at $20,000.

Wash., Seattle—Gerrick & Gerrick, Cen. Bldg., awarded contr. for superstr. of Eastlake Ave., brdg., at $45,391.

Wash., Seattle—Gerrick & Gerrick Co., Cent. Bldg., awarded contr. to erect steel brdgs. for Spokane & Seattle R. R. Co., at $30,000.

Wash., Tacoma—Hans Pederson, local, awarded contr. for constructing rein.-conc. brdg., at $47,720.

PROSPECTIVE WORK

ROADS AND STREETS

Ala., Gadsden—Plans approved by Fed. authorities for constr. of 5-mile paved rd. to be known as Hoke's Bluff and Attalla Hwy. project. Approx. cost, $20,000. Contract will be awarded about May 7th, and will be under supervision of State Hwy. Engr., W. S. Keller.

Ariz., Phoenix—About 72 miles of rd. planned through Maricopa, Pinal and Gila Cos. Lamar Cobb, State Engr.

Ariz., Superior—Grand Pacific Copper Co., will expend ten to twelve thousand dollars on road improvt., co-operating with county in bldg. proposed Ray cut-off road. Work will also begin shortly on Mesa end of state hwy. to connect state capitol with Globe-Miami dist., passing through Superior's Apache canyon.

Ariz, Tombstone—$500,000 worth of bonds of one million dollar road issue, Cochise Co., have been sold by Co. Supvrs.

Ark., Clarksville—$259,000 bonds sold by Comrs. for Rd. Distr. No. 1. Funds will be used to build asph. rd. east and west across Johnson Co.—35 mi.

Ark., Lake City—Plans approved by State Hwy. Dept., for 25 mi. road to connect Lake City, Nettleton and Bay; macad., bitum. binder. Approx. cost, $325,000. Craighead County.

Ark., Little Rock—$178,463 Fed. aid for 12 road improvt. districts. Aggregate length of roads, 313 miles. Est. cost of construction, $1,127,000.

Ark., Little Rock—$2,750,000 bond issue awarded a syndicate of St. Louis banks and bond companies. Construction work will begin at once on Ark.-La. Hwy. Northern end of rd. will be at Grady, Lincoln Co., South to La. line at two points, rd. will follow largely line of Missouri Pacific R. R.

Ark., Rogers—City considering bldg. of hwy. 32 mi. long—this city to Madison County line. Est. cost, $60,000. Leander Norris, Co. Judge, Benton County.

Cal., Los Angeles—Harbor Comn. has sent to City Council plans for rdway. across Terminal Isl., to tap Southwestern Shipbldg. Co's. proposed plant and other industrial wks.; one end of rd. to connect with Anaheim rd. in Wilmington and the other to lead into Fish harbor.

Cal., Los Angeles Harbor—$160,000 bonds voted for purpose of bldg. new rd. which will cut distance betw. Los Angeles Harbor and Lomita 5 mi. over present route via. Redondo Blvd.

Cal., Paso Robles—Work soon to start on Cholame pass state hwy., lateral to connect San Luis Obispo with Bakersfield. First Contr. to be let will be for constr. of a nine-mile sec. over Cholame flat and through Palonia pass leading to Antelope Valley. Surveys being made and bids for first section to be called for this month.

Cal., Sacramento—State has voted $15,000,000 to be expended in perfecting state highway system.

Cal., San Francisco—Plans being considered for new hwy., to start from 17th and Castro Sts., traverse old Corbette rd. to western side of Twin Peaks and connect with Junipero Serra Blvd. in Ingleside District. It will have max. grade of 8 percent. It will serve as connecting link betw. narbor and ocean and be main artery for commercial traffic. Petition has been signed for this road by more than 2,000 property owners.

Cal., San Pedro—$160,000 bonds voted by Improvt. Dist. No. 7 (San Pedro and Wilmington) for constructing abt. 4 mi. conc. hwy. connecting above towns with Harbor City. Rdway will be 22 ft. wide, paved with 6-in. conc., with 5-in. shoulder on each side.

Ga., Atlanta—Georgia Hwy. Dept. announces $402,750 appropriation to be divided as follows among 28 counties: Bleckley, $10,000; Bullock, $15,000; Candler, $8,500; Carroll, $20,000; Charlton, $20,000; Cherokee, $33,500; Cobb, $15,000, etc.

Ga., Marietta—$25,000 appropriation to be made by Cobb Co., Commrs. for construction of asph, military road from Camp Gordon throughout Marietta to U. S. military range north of city. Est. cost, $120,000.

Idaho, Twin Falls—$200,000 road bonds sold and Buhl Independent Hwy. Dist. is now ready to begin road bldg. This is but one-half the amt. of the road bonds which have been authorized.

Ill., Chicago—State Hwy. Dept., Springfield, had plans approved by Fed. Govt. for bldg. 230 mi. of rd. in state as follows: Dixie Hwy.—Chicago to Danville; Lincoln Hwy.—Chicago to Fulton, connecting there with Clinton, Ia.; 35 mi. rd. betw. Chicago and Waukegan to connect with Milwaukee Rd. at Illinois-Wisconsin border; 40 mi. rd. —Chicago to Joliet; 25 mi. rd.—Peoria to Springfield. Est. abt. $4,100,000. H. E. Bilger, Rd. Engr.

Ill., Joliet—City will expend $84,129 for street improvts. Among some of the streets to be improved are: Iowa Ave., Mississippi Ave., Third Ave., Grant Ave., etc.

Ill., Rockford—Petitions being circulated for election to vote on bond issue of $95,000 for purpose of bldg. 4½ miles of rd.—Camp Grant to Ogle County line.

Ill., Springfield.—Approx. $9,000,000 available from county bond issues and government appropriations for construction of rd. betw. Chicago and St. Louis.

Ind., Columbus—Council has voted appropriation of $58,250 for constr. of Indianapolis-Louisville market hwy.

Ind., Ft. Wayne—Plans under way to lay out boulevard from No. 3 pumping sta., one mile south to St. Mary's River at end of Foster Park. Blvd. will be 100 ft. wide. City will soon call for bids for asph. pavement on Anthony Blvd.—Lake Ave. to State Blvd.

Ia., Waterloo—Road will be paved betw. here and Cedar Falls—about 6 mi. Est. cost, $110,000. J. J. Rainbow, Aud., Black Hawk Co.

Kans., Topeka—State now ready to let contracts for bldg. first 200 miles of perm. hwys. Actual construction cost is $2,500,000; of which Govt. appropriation is $420,622. Most important is road connecting Ft. Leavenworth with Ft. Riley. Rd. from Topeka east to Ft. Leavenworth will be of conc. (48 miles) at $18,000 a mile. Bourbon Co. is planning to construct 34 mi. waterbound macad. roads. Labette Co. will build 43 miles of gravel road.

La., Monroe—Capital Issue Comm., Washington, has approved $2,750,000 bond issue voted for improvt. of hwys. through Lincoln, Desha, Ashley, Chicot and Drew Counties, Ark.

Md., Annapolis—Bill providing for $3,000,000 loan, to complete state rd. sys. and for repairs, introduced in Senate by Senator Stifler; Among the rds. to be improved are following: Garrett-Oakland-Hutton Rd.; Alleghany-Ellerslie Rd., Washington Rd., surfacing of rd. from Weverton to Harpers Ferry, and many others. Bridges will also be built where necessary.

Mass., Lowell—City considering loan of about $70,000 to carry out paving program. Streets to be improved are as follows: Appleton—$10,000; Central St., $25,000; Marginal St., $10,000; Westford, $11,000. In addition, Council has instructed Comr. to have estimates prepared of cost of paving Lawrence St.—Rogers to Watson.

Mich., Detroit—$80,000 appropriation made for completing 10 mi. of rdway. in Monroe Co.—18 ft. conc. rd., with 5-ft. shoulders—which will give an improved roadway—Detroit to Toledo. Work to start soon.

Mich, Detroit—City again considering plan to widen Woodward Ave.—Adams Ave., to Baltimore Ave. Est. cost, $1,000,000.

Mich., Lansing—$65,000 appropriation approved by Mich. War Preparedness Bd. Largest item is $35,000—state aid towards construction of new main hwy. from Battle Crk., Calhoun Co., to Camp Custer, estimated cost of which is $80,000. This will parallel Upton Ave. rd. and relieve congestion on this hwy.

Mich., Lansing—State Hwy. Comn. considering public hwy., eastern and northern Michigan. R. W. Roberts, struc. engr. and supvr., 116 N. Washington Ave., Saginaw. Farmington Twp. also contemplates paving four mile rd., 1-course conc. Private plans, $100,000. F. F. Rogers, Comr., Mich. State Hwy. Dept.

Mich., Saginaw—Following is road work decided upon by Co. Rd. Comrs: Widening of Williamson rd. to Bridgeport to 10 ft., with suitable shoulders and resurfacing with 5-in. thickness of gravel; Frankenmuth rd., from Cook's Cors. to village will be treated with tarvia; repairs will be made on Genesee rd., from city to south county line—from Birch Run south it will be scarified, re-rolled and kept in repair. All old macad. rds. will be patched with fire repair stone or gravel and treat. with calcium chloride.

Minn., Minneapolis—$81,000 voted by Co. Comrs. for grading and graveling dirt rds., in Hennepin Co., during 1918; $70,000 also voted for repairing and maintenance of roads in said Co. during 1912. E. E. Terrel, Co. Survyr., Court House, Minneapolis.

Mo., Independence—3 miles brk. paving planned on Van Horn Rd. Est. cost, $180,000. Plans also being prepared by Oliver C. Sheley, Jr., Co. Surv., Jackson Co., for rock rd., betw. Sugar Crk. and Cement City—1.25 miles.

Mo., St. Louis—Ord. passed authorizing expenditure of $85,000 for grading Kingshighway—Natural Brdg. Ave., to Florissant Ave.

Mo., Savannah—Andrew County has called election to vote on $1,000,000 bond issue for bldg. hard-surfaced roads. It is planned to bld. 125 miles of roads. Jno. A. Miller, Co. Clerk.

L. I., Mineola—Plans under way to improve following roads in towns of Hempstead and No. Hempstead; Grand Ave., 3,155 ft.; Grand Ave., 900 ft.; betw. Lynbrook and Merrick Rd., 660 ft.; Hilton Ave., 5,665 ft.; Roslyn-Mineola Rd., 14,500 ft.; Middle Neck rd., portion from car barn at Flushing and N. Hempstead's turnpikes to Main St., Port Washington, 13,000 ft. to be rebuilt.

N. J., Elizabeth—County officials have outlined report of necessary improvts. This includes work on 30 rds. (68 miles). Matl. to be used will consist of cutback asph. oil, light oil on macad. and heavy oil for repair work. Est. cost of oiling process, $134,931. Reconstruction wk. will include 600 ft. on Elizabeth Ave., Hillside—brk., with conc. base; abt. 1,000 ft. conc. rd. base and bitum. top in Chatham adjoining Passaic River; abt. 2,000 ft. on Terrell Rd., Eanwood Boro.—conc. fdn., bitum. top dressing, and other improvt. work.

N. J., Newark—Essex Co. expects to spend more than half a million on roads if recommendations of Co. Engr. Reimer are carried out. Programs call for expenditure of $413,156 for resurfacing county roads, of which county must pay $256,416. It also includes resurfacing of following: Stuyvesant Ave., Irvington, $58,137; Gregory Ave., W. Orange, $71,389; Watchung Ave., Montclair, $83,387, and others.

N. J., Trenton—Ord. passed to repave various streets as follows: Hanover St.—Broad to Warren Sts., sheet asph. on new 6-in. conc. fdn.; N. Stonton St.—State to Commerce Sts., sheet asph. on exist'g. conc. fdn.; Port Warren to Broad, sheet asph. on pres. conc. fdn.; Olden Ave.—Clinton Ave. to Assunpink Crk., sheet asph. on new 6-in. conc.; Chancery St.—State to Hanover, sheet asph. on exist'g. brk. fdn., and a number of others. Est., $39,5000. Leon D. Hirsch, City Clk.

N. J., New Brunswick—Middlesex Co. contemplates improving State St., and paving rd.—Woodbridge to Sowaren. Extensive improvts. also planned on rds. in Parlin. Approx. cost, $140,000. Alvin B. Fox, Co. Engr., Perth Amboy.

N. Y., Albany—Governor Whitman has signed Machold Bill appropriating the sum of $2,015,000 as state's contribution toward repair and improvt. of hwys.; also $60,000 for hwys. in Indian reservations and $20,000 for county roads.

N. Y., Albany—Dunkirk residents strongly in favor of improving 35 miles of Buffalo-Erie Rd., betw. Silver Crk. and state line. Delegation of citizens from Dunkirk will confer with Hwy. Comr. Duffey with regard to this proposition.

N. Y., Syracuse—Good Rds. Comm., of Chamber of Commerce have adopted resolution to keep main hwy. betw. Buffalo and New York in first class condition for passage of the 70,000 army motor trucks during summer. Est. cost, from $1,000,000 to $3,000,000.

N. D., Bismark—$350,000 to $500,000 will be expended on road improvts. in this state during the summer.

N. D., Fargo—Approx. $500,000 will be expended on hwy. improvts. in state this year. Work now designed for abt. 400 mi. fed. aid projects; average length of jobs, 15 miles—longest, 30.5 mi., and shortest, 3.6 mi.

N. D., Mott—Hettinger Co. considering plan to build 74 miles of roads this spring. Fed. aid. Plans under way to bld. New England-Dickinson Rd. E. C. Roberts, Co. Aud.

O., Chillicothe—$1,000,000 fed. aid to be requested for purpose of improving various roads entering city. Cincinnati to Chillicothe hwy. is among the most important. Appropriations to amt. of $376,000 available for improvt. of this road in Highland Co.

O., Cincinnati—Ords. passed to issue bonds in sum of $21,500 to pay City's portion of cost of improving Central Ave.—4th St. to Liberty, and $13,000 for improvt. of Freeman Ave.—5th to Kenner St.

O., Conneaut—Erie Co., Pa., Commrs. have decided to pave main road east from this city through state; Erie Co., N. Y., will also improve same hwy. With paving of road from Ashtabula to Conneaut (also other work) there will be 60 mi. new paving in 3 states, giving unbroken improved rd.—Toledo to Buffalo.

O., Columbus—Council has voted for issuance of $30,000 bonds for purpose of improving 16 streets in nearly every residential section of City.

O., Delaware—$56,000 state aid received for improvt. of Delaware-Marysville rd. this summer. Survey now being made. Rd. will be improved from Houk Cors., 2 mi. west of city to Marysville county line.

O., Lima—State has agreed to pay $50,000 toward completion of paving Lima-Canton-Marion Hwy., and Lima-Ottawa Rd. Resolution adopted by Comrs. to issue $19,000 bonds to cover addn. expense of Ottawa-Lima and Lima-Kenton roads.

O., Salem—Completion during coming summer of all unimproved secs. of Cox Hwy. through city—Westville to Penn. state line; is assured. State Hwy. Dept. will give $50,000 toward its completion; also $15.000 for Lincoln Hwy., and an additional $60,000 for latter route as soon as possible. Approx. cost, $150,000.

O., Sandusky—State Hwy. Comm. will allow Erie Co. $52,000 for road construction this year. $30,000 of this sum will be expended on 40-mile stretch of conc. rdway. on Columbus pike. Co. Engr. L. A. Schultz estimates cost of this work at $109,000. State Hwy. Dept. will also allow County $17,000 for improvt. of rd. from Castalia to Clyde.

Pa., Easton—Bids will be called soon for construction of Martin's Crk.—Bangor rd., which will be 30 ft. wide with 16-ft. path of conc. Est. cost, $18,000 a mile (distance slightly more than 6 miles). Total cost abt. $110,000. State and County will share expense of building. W. R. Wolfinger, Div. Supt., State Hwy. Dept.

Pa., Erie—Erie Co., Rd. Supvrs. have voted to pave Ridge Rd., in order to meet government needs for hwy. connecting Ohio and New York through Pennsylvania.

Pa., Erie—Proposition to construct main hwy. from lakes to tide water through Erie, Vonango, Clarion, Jefferson and Clearfield counties, has received numerous endorsements.

Pa., Erie—Erie County will expend $1,500,000 on state roads within the County; Crawford Co. will expend $300,000 and will submit to voters bond issue of $800,000.

Pa., Lancaster—Lancaster Co. contemplates road abt. 12 miles in length betw. here and Maryland State line. Est. cost, $240,000. State aid. Alf. Wood, Co. Surv.

Pa., Philadelphia—Industrial centers along Delaware River, Delaware Co., will be connected with City by boulevard to extend from present City line at Cobbs Crk., to Delaware state line.

Pa., Pittsburgh—Dept. Pub. Wks. soon to award contracts for paving, grading, bldg. curbs and gutters, on Realty, Tonopah and Maple Aves., Tokio St. and Smithway, et al.—34 to 36 ft. wide, brk. or stone blk. Approx. cost, about $166,100. R. Swan, City Engr.

Pa., Reading—State road betw. St. Clair and Frackville is being considered. New rd. will gradually ascend mountain side making grade less than present road. Est. cost, abt. $150,000, to be paid for on fifty-fifty basis.

Pa., Reading—Plans under way for bldg. conc. post road betw. Reading and Harrisburg. Est. cost, $30,000 a mile; Fed. Govt. will assume one-third of cost, ($10,000 a mile). Total est. cost, $340,000. City also considering widening Center Ave. this spring.

Rhode Island—State Bd. Providence, has filed plans with town of Narragansett for straightening and relocating portion of main rd. betw. Boston and New London; 1 sect. 6,100 ft. long; the other 7,200 ft. long. Approx. cost, betw. $65,000 and $75,000.

Tenn., Nashville—Final figures for road construction this year on file with State Hwy. Comm. State funds and Fed. aid total $4,512,302. This amt. does not include expenditures by counties from own funds nor revenue from tax on motor-driven vehicles. Roads to be built include Memphis-to-Bristol Hwy., Dixie Hwy., Chattanooga-Bristol Hwy., Buffalo Trail and Shiloh Park Hwy. A. M. Nelson, State Hwy. Engr.

Tex., Bogata—$100,000 bonds voted by Bogata Good Rds. Dist. in Rod River Co. District is 15 mi. long and is connecting link in Choctaw Natl. Hwy. to Titus Co.

Wash., Spokane—Inland 7mpire will put all present hwys. in excellent condition this season. More than $1,000,000 available for contracts for roads adjacent to Spokane; quarter of million dollars to be used in Spokane County.

W. Va., Wayne—$1,000,000 bonds voted by Wayne Co., for road constr. betw. Cabell and Mingo Co. lines.—brk. on conc. or macad., 30 mi.

WEALTH OF COIN WILL BE SPENT FOR GOOD ROADS

Quarter Billion to be used in 1918 to Improve the Highways

The amounts to be spent on road improvement this year, as compared with those of last year, are reported as follows:

	1917.	1918.
Alabama	$ 150,000	$ 2,500,000
Arizona	750,000	3,000,000
Arkansas	4,000,000	12,299,000
California	3,210,000	12,000,000
Colorado	3,100,000	3,635,000
Connecticut	2,500,000	2,500,000
Delaware	320,000	1,000,000
Florida	2,000,000	2,750,000
Georgia	3,500,000	4,300,000
Idaho	800,000	800,000
Illinois	5,500,000	17,000,000
Indiana	6,000,000	17,380,000
Iowa	15,140,000	15,500,000
Kansas	6,500,000	10,500,000
Kentucky	4,500,000	4,500,000
Lousiana	8,000,000	5,300,000
Maine	400,000	1,150,000
Maryland	2,250,000	2,700,000
Massachusetts	4,500,000	3,033,000
Michigan	1,500,000	2,300,000
Minnesota	3,884,925	7,700,000
Mississippi	1,500,000	3,500,000
Missouri	2,500,000	4,000,000
Montana	2,000,000	3,000,000
Nebraska	3,500,000	1,279,757
Nevada	300,000	560,000
N. Hampshire	1,038,704	587,000
New Jersey	4,500,000	8,100,000
New Mexico	500,000	1,500,000
New York	7,000,000	10,000,000
N. Carolina	1,750,000	2,500,000
N. Dakota	1,000,000	3,500,000
Ohio	2,829,858	6,000,000
Oklahoma	3,500,000	6,400,000
Oregon	1,371,226	5,653,516
Pennsylvania	3,250,000	5,750,000
R. Island	471,724	600,000
S. Carolina	1,173,000	1,498,000
S. Dakota	350,000	1,500,000
Tennessee	2,000,000	3,000,000
Texas	5,000,000	25,000,000
Utah	943,129	1,131,754
Vermont	485,000	685,000
Virginia	2,332,577	2,115,000
Washington	3,500,000	8,408,250
W. Virginia	8,000,000	14,000,000
Wisconsin	4,588,717	10,125,000
Wyoming	400,000	806,000
Totals	$144,298,860	$263,096,610

Big Appropriations in West.

The exact total of proposed expenditures through federal, state and county channels is reported as $263,096,610. This exceeds the 1917 total by $118,797,750. Appropriations in the middle west and south are far greater than those in other regions, Texas leading the roster of states with a road budget of $25,000,000. Indiana and Illinois come next with approximately $17,000,000 apiece.

SEWERAGE AND SEWAGE TREATMENT

Ariz., Douglas—City considering possibility of laying sewer line from city limits to Camp Harry J. Jones.

Ariz., Globe—City Council has decided to sell $240,000 bonds for construction of sewer system. J. F. Mayer, City Clk.

Ariz., Jerome—Wm. Arndt, San Francisco, has offered to build redwood septic tank for city at cost of about $5,000. Olmsted & Gillelon, Los Angeles, Conslt'g Engrs., will draw plans for same. Conc. septic tank would cost $20,000.

Cal., Galt—Plans prepared for City by Calif. Comn. of Immig. & Housing, for sewerage sys. and Imhoff septic sys. Approx. cost, $17,500.

Cal., King City—City Engr., J. E. Olive preparing plans for sewage disp. plant, including septic tank and filter bed.

Cal., Los Angeles—Bd. Pub. Wks. has ordered plans and specifs. prepared for establishment of unit of Skeats sewage disp. sys. on First St., San Podro Distr. If this unit proves successful City will install complete sys., by which it is estimated City can be saved approx. $3,000,000. This will eliminate necessity of bldg. outfall sewer connect'g. Hyperian with Hollywood, and construct'g. Imhoff septic tank sys.

Cal., Paso Robles—Plans under way to build 6-in. iron stone pipe sewers in 19th 11th and Olive Sts. H. Meier, Clk.

Cal., Watts—Elec. will probably be held soon to vote on sewer bond issue, for purpose of bldg. trunk line san. sewer in Compton Rd., Lynwood Rd., and Wilson Ave. Est. cost, $85,000.

Ct., Bridgeport—Plans under way to install four Reinsch-Wurl screens in sewage disposal plant to be built in Bostwick Ave. Jas. A. McElroy, City Engr.

D. C., Washington—Bill, creating san. distr. in Maryland territory adjacent to City, and authorizing exten. of Dist. of Col. sewers and water mains, favorably reported to Senate by Finance Comm. Bill has already passed house of delegates.

Ga., Atlanta—City considering bldg. lateral sewers in Peachtree, Myrtle and Ashby Sts.; Highland and Bellwood Aves.; also extend'g. 10th Ward san. trunk sewer. Approx. cost, $10,400. H. L. Collier, Ch. of Constr.

Ill., Chicago—Sanitary Dist. Bd. announces that practically every obstacle to bldg. model intercepting sewer and sewage treatment plant to clean up Desplaines River, has been removed. Construction work will begin in about 30 days. Sewer will be about 3 mi. long and will cost, including treatment plant, abt. $750,000. Main sewer will start on north at 11th St., in Maywood, follow west bank of river south to treat. plant. Size will vary from 24-in. pipe at upper end to 5-ft. tunnel at outlet. Siphons will be constructed beneath river to care for sewers discharging from east bank in villages on line of route. Electrically-driven pumping plant will be constructed at side of treat. wks.

Ind., Indianapolis—Resolutions adopted providing for bldg. at Sellers farm—southwest of city at jct. of Big Eagle Crk. and White River—of a sewage disp. plant. Est. cost, $1,012,000. Preliminary plans, specifs. being prepared. Federal approval necessary before work can be started.

Ia., Des Moines—City considering sewer construction in So. West Des. Moines. Government has declared locality unhealthy.

Kans., Wichita—City considering constr. of storm sewer to provide darinage for residence dist. at foot of College Hill dist. Approx. cost, $100,000.

Mass., New Bedford—$10,000 appropriated by City Council for constr. of the Purchase and Brook St. sewers. Investigation will also be made as to advisability of install'g. catch basin at corner of Middle and Purchase Sts.

Mass., Wellesley—Plans under way to bld. abt. 12,000 ft. sewer as bal. of sewer from here to Metropolitan system, involving 1,300 ft. rock for tunnel; bal. earth trenching and laying 33x36 and 36x40 in. conc. pipe.

Mich., Battle Creek—$40,000 bonds voted for construct'g. large sewers on Angell St., and Upton Ave.

Mich., Bay City—City planning to build sewers. Agout $15,000. A Thompson, City Engr.

Mich., Detroit—Borded cities have voted in favor of $210,000 bond issue for sewer system. Morris Knowles, Engr., Pittsburgh, in charge of plans. Sandwich, Windsor, Ojibway, etc., interested.

Mich., Wyandotte—Mason L. Brown & Son have prepared plans for storm sewer to drain northwest sec. of city. Est. cost, $14,000. Plans approved by City Council. At Spring elec. citizens will vote on proposition to construct sewer sys. in W. Wyandotte.

Minn., Duluth—City will soon let contr. for bldg. sewerage sys. along Woodland Ave.—4th to Austin Sts. Abt. $50,000. L. Ayres, City Engr.

Minn., Fairmont—$50,000 bonds for construction of sewers and $20,000 for filtration plant voted at recent election. E. L. Lewis, City Clk.

Minn., Foley—Central Engr. & Constr. Co., St. Cloud, selected to prepare plans for sewer and water system. $40,000.

Minn., Minneapolis—$210,000 bonds sold for various city improvements: $150,000 for sewers.

Mo., Chillicothe—City Council has instructed City Engr. tot prepare est. plans and specifs. for constr. of 8-in. sewer on Mansur St., running full length of street; also for constr. of sewer beginning at point 300 ft. south of intersec. Woodrow Ave. and Clay St. in Western Heights, running north to Clay, thence west to Williams hollow. This sewer will also be 8 inches.

Mo., Pleasant Hill—Plans prepared by W. B. Rollins & Co., 209 Railway Exch. Bldg., St. Louis, for sewer construction in a number of streets. Approx. cost, $30,000.

N. J., Far Hills—Sewage Comn. and State Bd. of Health considering plans for new sewage disp. plant. About $12,000.

N. J., Hoboken—Resolution introduced by Director Fagen, Dept. of Sts. and Pub. Improvts., providing for purch. of 3¾ acres of land in Rockaway watershed below Boonton Dam, for constr. of sewage disp. plant connected with intercept'g. sewer at Boonton.

N. J., Pitman—Plans under way for constr. of new sewer system. Total est. cost, including 2 disposal plants—$156,027, of which amt. New Jersey Camp Meeting Assn., will pay $39,650 as its share of sewer constr. work within confines of the grove.

N. Y., Buffalo—City will soon ask bids for bldg. 6,258 ft. sewers on Lang Ave. and Newburg St.; Potter Rd.; Hagen, Courtain dand Newburg Sts., etc. Work involves 4,353 ft. 10, 12 and 15-in. tile sewer pipe; 1,505 ft. 24, 27, 33 and 36-in. brk. rein.-conc. and segmental blk. sewer pipe. G. H. Norton, City Engr.

N. Y., Flushing—Petition presented for construction of sewer and appurtenances in Robinson Ave.—Larch Ave., to Queens Ave., also in Lawson St., Kendall, Joslin, Junkerman, Hoogland, Grennell and various others.

N. Y., N. Y. City—Plans under way to build sewer in Newton—to run under Grand St., from Boulevard to L. Island R. R. Est. cost, $20,000.

N. Y., Rochester—Sewer will be constructed in Clifford Ave. district. Sys. will provide drainage for sect. bounded by Waring Rd., Culver Rd., Long View terrace and Clifford Ave. Est. cost, $90,000. It will also be necessary to construct pumping station to lift sewage from this system into Culver rd. sewer.

N. C., Benson—$50,000 bonds voted for sewer and water sys. construction. G. C. White, Durham, N. C., Engr. Ezra Parker, Mayor.

N. C., Gastonia—City contemplates bldg. septic tank for sewage disposal. Approx. cost, $15,000 to $20,000.

O., Akron—Ord. passed by Council to issue $50,000 bonds for improvt. of sewers and sewage disp. plant. W. A. Leisloft, City Engr.

O., Barberton—Resolution adopted to build sewers in about 65 streets. H. W. Alcorn, City Engr.

O., Chillicothe—City considering bldg. of san. sewer from North St. to intersec. of Vine and High, on High St.; also paving High St. with brk. on concrete base. Est. cost of work, $23,918.

O., Cleveland—Resolutions drawn up to constrtuct sewers in following sts.: W. 28th St., E. 130th St., E. 139th St., Darwin Ave., Bosworth Rd., and many other Sts. and Aves.

O., Penmore—$75,000 and $32,000 bonds being sold for purpose of constructing storm water sewers.

O., Toledo—$75,000 bonds tot be sold for sewer construction and water conduits.

O., Youngstown—Resolutions drawn up to construct sewer in Parkview Ave., Springdale Ave.; also sewer outlets for Southern sewer distr.

Ore., Astoria—Resolution drawn up for constr. of 10-in. sewer on 8th St., from Niagara south; also 12-in. sewer on Franklin Ave.—38th to 40th. Petition filed by number of property owners for sewer sys. along Antwerp, Folrence ,Dresden, Agate Aves., and emptying into Young's Bay.

Pa., Allentown—City Engineer's office has started on work of preparing plans for sewerage sys. Hwy. Dept. laying out farm with reference to filter beds which will be located there. Asst. Engr. Parry planning trunk sewer which will extend from 3rd and Walnut Sts., to Gessingers, where disposal plant will be located.

Pa., Ambridge—Morris Knowles, Engr., Pittsburgh, has drawn plans for 5 different styles of san. sewer systems and disposal plants. Est. cost of same runs from $109,000 to $148,000. For latter sum joint system could be built to serve both Ambridge and Leetsdale.

Pa., Philadelphia—Estimates for sewers in 250-acre plot for 2000 house in connect. with Hog Isl. Shipbldg. Plant, have been sent to J. Rogers Fannery and Owen Brainard at Washington, by Chester E. Albright of Survey Bureau. Approx. cost, $500,000.

Pa., Philadelphia—City will build Cobb Creek intercept'g. sewer in 69th from Girard to Malvern Aves., brk. at cost of $30,000; rectangular rein.-conc. sewer in Venango St.—Balfour to Armingo—$50,000; interceptg. sewer in 40th Ward, low lands, no streets, $50,000; circular brk. sewers comb. sys., in Knorr, Charles, Longshore, Gilman, Tyson and Crabtree Sts., $65,000; circular brk. sewers. comb. sys., in proposed drainage sts., from intersect. of Broad St. and Godfrey Ave., to Old York Rd.; in Old York Rd.—15th to 18th Sts., and 66th and 67th Aves., $155,000; circ. brk. comb. sys., across Northeast Blvd., and in Summerdale Ave., $25,000; san. brk. sewer, Wissahickon low lev. sewer through Fairmont Pk., $80,000; circ. brk. sewer. comb. sys., Rock Run sewer in Ashdale St., $80,000; circ. brk. sewer, comb. sys., in B St., $30,000; circ. brk. sewer, comb. sys., in Miffin St., $70,000; circ. brk. sewer, comb. sys., Pratt St., $75,000.

Pa., Pittsburgh—After investigating several styles sewage disposal plants, Engr. Howell has adopted for the town a single screen chlorinating plant, with one screen. Est., $22,000. If State authorities demand a two-screen plant, $20,000 will be added to cost.

Pa., Reading—City contemplates loan of abt. $250,000 with which to finish house sewer constr., and to build viaduct at foot of Bingham St., $75,000 will be required for sewer work.

R. I., Warwick—Town is contemplating construction of sewer system. Stephen D. M. Gate, Chemist and San. Engr., estimates cost from $225,000 to $250,000.

R. I., Woonsocket—Resolution adopted to appropriate $20,000 for constr. of sewer in Upper So. Main St.

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The majority of all municipal issues do not reach the investor directly, but pass through the hands of a dealer who specializes in their purchase and sale.

There are several hundred municipal bond dealers located throughout the country. Many of these bond firms buy a great variety of issues from counties, cities and villages located in the East and West, North and South.

Since a really successful sale will only result from competitive bidding participated in by many different bidders, it is clear that a municipality should advertise its bond offering in a paper specializing in bond news and read by all the dealers interested in this news.

The Bond Buyer, issued daily and weekly, is just such a medium! It never speaks of anything but municipal bonds, and, after twenty-five years of this specilization, it has come to be accepted by legislators and public officials as **"The Authority on Municipal Bonds."**

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If you are seeking employment, have second-hand machinery for sale, want to purchase machinery or supplies, want competent men to fill responsible positions, or have proposals to advertise, an ad. in these columns will put you in touch with responsible parties who can supply your wants.

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ELKHART, INDIANA

Bids received until May 7, 1918.

NOTICE TO BRIDGE BUILDERS

Notice is hereby given that bids for building the county bridges to be built by Kearney county for the year 1918 will be received by the county clerk of said county. Bids must be according to plans on file in the clerk's office and all bids must be accompanied by certified check for $200.00, payable to the county clerk of Kearney county, to be forfeited in case the bidder refuses to enter into contract with said county in the event of the awarding of the contract. The board reserving the right to reject any and all bids. Said bids to be filed with the county clerk of said county not later than 12 o'clock noon on May 7, 1918. Bids will be opened by the county clerk in the presence of the county board of supervisors at their room in the court house of said county at Minden, Nebraska, at 2 o'clock p. m.

Dated at Minden, Nebraska, this 14th day of March, 1918.

I. J. THOMSEN,
County Clerk.

Bids received until May 7, 1918.

ENLARGEMENT OF FILTER PLANT

Fort Worth, Tex.

Sealed proposals will be received by the Mayor and Board of Commissioners of the City of Fort Worth, Texas, until 9:00 o'clock Tuesday, May 7, 1918, for the construction of preliminary treatment works at the water filtration plant in Fort Worth, Texas.

The work covers the construction of preliminary treatment works for a rapid sand filtration plant having a capacity of 10,000,000 gallons per 24 hours, and consist mainly of the construction of a chemical house, aeration basin, mixing chamber, and two sedimentation basins, each having a capacity of 1,250,000 gallons; and of the laying of certain new pipes, sewers, conduits, etc.

Plans and specifications may be obtained from F. J. Von Zuben, City Engineer, City Hall, Fort Worth, Texas, and also from the office of John H. Gregory, Consulting and Designing Engineer, 170 Broadway, New York City. A charge of $25.00 will be made for each set of plans and specifications, which amount will be refunded upon the return of the plans and specifications in good condition.

Each bid must be accompanied by a certified check on a Fort Worth bank for $6,000.00; and the successful bidder will be required to furnish a surety company bond of $25,000.00.

J. C. LORD,
Commissioner of Water Works.

Bids received until May 7, 1918.

BRIDGE

Lake Worth, Fla.

Sealed bids will be received by the Board of County Commissioners of Palm Beach County, Florida, at the Clerk's office at West Palm Beach, Florida, up to 12 o'clock noon Tuesday, May 7, 1918, for the construction complete of a bridge across Lake Worth at Lake Worth, Fla., said bridge to consist of a 150-ft. steel swing draw, or a Scherzer rolling-lift steel span, with clear opening of 60 ft. All according to plans and specifications for said work on file in the office of the County Engineer, West Palm Beach, Florida.

Each bid must be accompanied with a certified check, payable to the Board of County Commissioners, in an amount equal to 2 per cent. of amount of bid as a guarantee that the bidder will, if awarded the contract, enter into contract promptly for said work and complete the same within the time limit named in his contract.

Each bidder will state when he will be ready to commence said work and the time required by him to complete the same.

Plans and specifications will be forwarded to any address on receipt of request made to R. F. Goodman, County Engineer, accompanied by remittance of $15, which remittance is to be refunded on the return of said plans and specifications to the Board of County Commissioners.

The Board reserves the right to reject any or all bids.

By order of the Board of County Commissioners.

L. TREVETTE LOCKWOOD,
Chairman.
GEO. O. BUTLER,
Clerk.

(Seal County Commissioners.)

Bids received until May 9, 1918.

DRAINAGE CONTRACT

The undersigned will receive sealed bids until noon May 9, 1918, for contract to clear right-of-way 100 feet wide and dig drainage canal 7.1 miles long; also for clearing right-of-way for lateral, same width and 800 feet long, and excavating same. A total of about 124,590 cubic yards of earth to be removed. Sizes of both main canal and lateral: Top width, 16 feet; average depth, 7 feet; bottom width 9 feet. All in Madison County, Tennessee.

Maps and profiles can be seen and further data obtained on application. Address A. W. Stovall, Chairman, Jackson, Tennessee.

Bids received until May 13, 1918.

NOTICE TO CONTRACTORS

Tullahoma, Tenn.

Sealed bids will be received by the Department of Highways, State of Tennessee, at the City Hall, Tullahoma, Coffee County, Tennessee, until twelve o'clock M., Monday, May 13, 1918, for the construction of 5.65 miles of State Highway No. 7 between the Franklin-Coffee County line, near Tullahoma, and the Coffee-Moore County line, in Coffee County, Tennessee.

Bids will be opened publicly at twelve o'clock M. on the above date.

The principal items of construction are approximately as follows:

Common excavation, 13,920 cu. yds.
Grader work, approximately 1 mile.
Water-bound macadam, 8 in. thick, 10 in. in width, 33,848 sq. yds.
Overhaul on macadam, 20,565 cu. yd. miles.
Furnishing, hauling, laying and backfilling 15-in. corrugated metal pipe or concrete tile, 120 lin. ft.; 20-in. corrugated metal pipe or concrete tile, 280 lin. ft.
Class "A" concrete, 40 cu. yds.
Class "B" concrete, 35 cu. yds.
Reinforcing steel, furnishing, hauling, bent and in place, 3,550 pounds.

Plans and specifications are on file in the Office of the Department of Highways, Nashville, Tennessee.

Any additional information may be secured from the State Highway Engineer, at Nashville, Tennessee.

The right to reject any or all bids is reserved.

Certified check for the sum of Two Thousand Dollars ($2,000) must accompany each bid as evidence of good faith and as a guarantee that if awarded contract, the bidder will execute contract and give bond as required by law set forth in the specifications.

(Note)—Where bids are submitted by mail prior to the date set forth in this notice, they should be sent to the undersigned at Nashville, at least two days in advance of the date set forth above.

State of Tennessee, Department of Highways.
J. J. MURRAY, Secretary.
A. M. NELSON, State Highway Engineer.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of MUNICIPAL ENGINEERING, published monthly at Indianapolis, Indiana, for April 1, 1918.

State of Indiana, County of Marion, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared A. P. Fox, who, having been duly sworn according to law, deposes and says that he is the President of MUNICIPAL ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, Engineering Publishing Company, Inc., Indianapolis, Indiana.
Editor, S. C. Hadden, 538 South Clark Street, Chicago, Illinois.
Managing Editor, S. C. Hadden.
Business Manager, J. H. Pritchard, 702 Wulsin Building, Indianapolis, Indiana.

2. That the owners are:

Engineering Publishing Company, Inc., Indianapolis, Indiana.
A. P. Fox, 704 Wulsin Building, Indianapolis, Indiana.
George O. Wildhack, 927 North Meridian Street, Indianapolis, Indiana.
C. A. Dickens, 538 South Clark Street, Chicago, Illinois.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are:

Frank S. Stalnaker, Trustee, Indianapolis, Indiana.
For A. P. Fox, Indianapolis, Indiana.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation

has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

A. P. FOX, President.

Sworn to and subscribed before me this 28th day of March, 1918.

(Seal) ANNA T. GAYNOR.

(My commission expires February 23, 1922)

Bids received until May 15, 1918.

State Highways

THE STATE OF DELAWARE STATE HIGHWAY DEPARTMENT

Dover, Del.

Sealed proposals will be received by the State Highway Department, at its offices in Dover, Delaware, until two (2) o'clock P. M., May 15, 1918, and at that place and time publicly opened and tabulated, for the construction of the State Highways in the State of Delaware, involving the following contracts:

CONTRACT No. 1: Kent County
4.05 miles cement concrete roadway.
CONTRACT No. 2: Kent County
4.90 miles cement concrete roadway.
CONTRACT No. 3: New Castle County
2.46 miles vitrified brick roadway with concrete foundation.
CONTRACT No. 4: New Castle County
3.75 miles vitrified brick roadway with concrete foundation.
CONTRACT No. 5: Sussex County
6.06 miles cement concrete roadway.
CONTRACT No. 6: Sussex County
4.90 miles cement concrete roadway.
CONTRACT No. 7: Sussex County
6.61 miles cement concrete roadway.
CONTRACT No. 8: Sussex County
6.36 miles cement concrete roadway.

Performance of contract shall commence within ten (10) days after execution of the contract and be completed on or before December 31, 1918.

Monthly payments will be made for (90) ninety per cent. of the work completed each month.

Bidders must submit proposals upon forms provided by the Department.

Each proposal must be accompanied by a surety bond, certified check, or money to the amount of ten (10) per centum of the amount of the proposal.

The envelope of the proposal must be marked: "Proposal for the Construction of a State Highway under Contract No. —."

The contract will be awarded or rejected within twenty (20) days from the date of opening proposals.

The right is reserved to reject any or all bids.

Plans and specifications can be obtained from the Department at Dover, Deleware, by depositing ($10) ten dollars which will be refunded when the plans and specifications are returned in good condition.

Plans may be seen, and specifications and detailed information obtained from

CHAS. M. UPHAM, Chief Engineer,
State Highway Department,
at Dover, Delaware.

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538 S. Clark Street
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WANTED—Salesmen to sell our truck unit for $198. You can secure the agency in your section for this $350 unit if you write at once. Save $152 by acting now, or make 77 per cent. on your money. This unit is a real truck unit and is best adapted to Ford chassis. Only limited supply on hand. Address "Truck Unit," care of Municipal Engineering, 538 S. Clark St., Chicago.

WANTED—Buyers for Dyke's Automobile Encyclopedia—1918 edition—now ready—900 pages—3,392 illustrations—6,000 lines of index. Dr. Dyke published the first practical book on automobiles in America and originated the first Auto Supply Co. in America in 1897. His 21 years of experience in the automobile business as a supply man and publisher is now represented in this new edition of his book. Fifty-eight of the leading automobile schools use part of his book to teach the fundamental principles of assembly of a car, engine principles and construction, valve timing, ignition and carburetion principles. There are 1,189 illustrations and 154 pages devoted to the repair subject alone. It is the most complete book on automobile repairing and adjusting so far published. In addition to the book there are two supplements on the Ford and Packard, with 332 illustrations and 91 pages. There are also five colored inserts. Also a dictionary. The price of the book remains at $3.00, altho the book is much larger and better than any previous edition. Send order to A. L. Dyke, Granite Bldg., St. Louis, Mo.

WANTED—Civilian workers for Ordnance Dept. Men having a high school education, some shop training and the natural ability to adapt themselves to new work, may qualify for a Government appointment in which under Government instructors, they will receive the necessary training for the positions to be filled. Those who have the required technical training will be placed and advanced as quickly as their ability justifies. Send in your own application and urge your associates who may be qualified to do so. These positions are under civil service regulations, but applicants will not be required to report for examinations at any place. Applicant will be rated in accordance with education and general experience. No applications will be accepted from persons already in the Government service unless accompanied by the written assent of the head of the concern by which the applicant is employed. Papers will be rated promptly and certification made with least possible delay. Apply or write for further information to C. V. Meserole, Special Representative of the Ordnance Dept., U. S. A., Room No. 800, 79 Wall St., New York, N. Y.

Do not permit Congress to Destroy the Great Mechanism of Selling and Distribution Through a Form of "Zone" Postal Legislation—with Postal Rate Increases of 50 to 900 per cent.—that has been condemned by every Postal Commission. It was also condemned by **President Woodrow Wilson** when Governor of New Jersey in these words:

"This proposed new postal rate would be a direct tax, and a very serious one, upon the formation and expression of opinion—its more deliberate formation and expression just at a time when opinion is concerning itself actively and effectively with the deepest problems of our politics and our social life.

"To make such a change now, whatever its intentions in the minds of those who propose it, **would be to attack and embarrass the free processes of opinion.** Surely sober second thought will prevent any such mischeivous blunder."

Write to your Congressman at once and demand the repeal of this destructive 50 to 900 per cent. periodical postage increase! DO IT NOW!

Chicago Will Resume Street Paving Work

Restoration of Old Prices by Contractors Brings Decision to Act.

Work on paving Chicago streets, which was curtailed when the cost of material took an upward trend, is to be resumed and many miles of worn and rough streets will be replaced by smooth surfaces as the result of a 15 per cent. cut by the contractors.

Paving contractors have submitted their estimates of cost to the city for the year 1918. Asphalt, per lineal foot, will cost property owners $8; brick, $8.75, and asphalt macadam, $6.75. These figures are below the estimates of the city's engineers. It was this discovery which led to the decision to resume paving work. The estimates of the city's engineers were, per lineal foot: Asphalt, $9.50; brick, $10, and asphalt macadam, $8.

"This means," said Michael J. Faherty, president of the board of local improvements, "that there will be no supplemental assessments. In the three years of my administration asphalt has advanced from $1.75 to $2.21 per yard, an increase of 26 per cent. Brick in the same period has advanced from $2.21 to $2.89 per yard, an increase of 30 per cent. Asphalt macadam has advanced from $1.21 to $1.45 per yard, an increase of 20 per cent. Now old prices are restored."

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We are sure this is due to the fact that the publication reaches the class of trade interested in our equipment. We are confident that they have an excellent list of subscribers who not only are interested in the publication but the advertisements carried by it. The paper is well edited and covers a great field of usefulness. This is our opinion based on experience and facts with this publication.

Yours very truly,
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You will be surprised at the speed. At the Smooth, Clean, Square Cut. No filing or reaming after the Automatic Strickler has done its work. As smooth on 30″ pipe as on ⅜″. Each size cuts a range of pipe sizes.

Just tell us the size of Pipe you are going to cut. No obligation on your part.

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STEWART SEWER CLEANING MACHINE

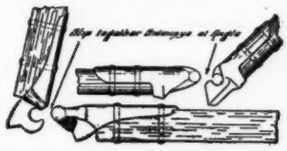
Water Cleaning System if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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No Deep Shoulder Cut for Couplings—Rods retain full size and strength

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Buy Labor-Saving Machinery

Labor costs more than ever before. Feed is high and going up. Horses were never so valuable. Don't use skilled men and expensive teams to do work that can be done more quickly, more efficiently and more economically by a machine. Now is the time to place your orders if you would make sure of deliveries.

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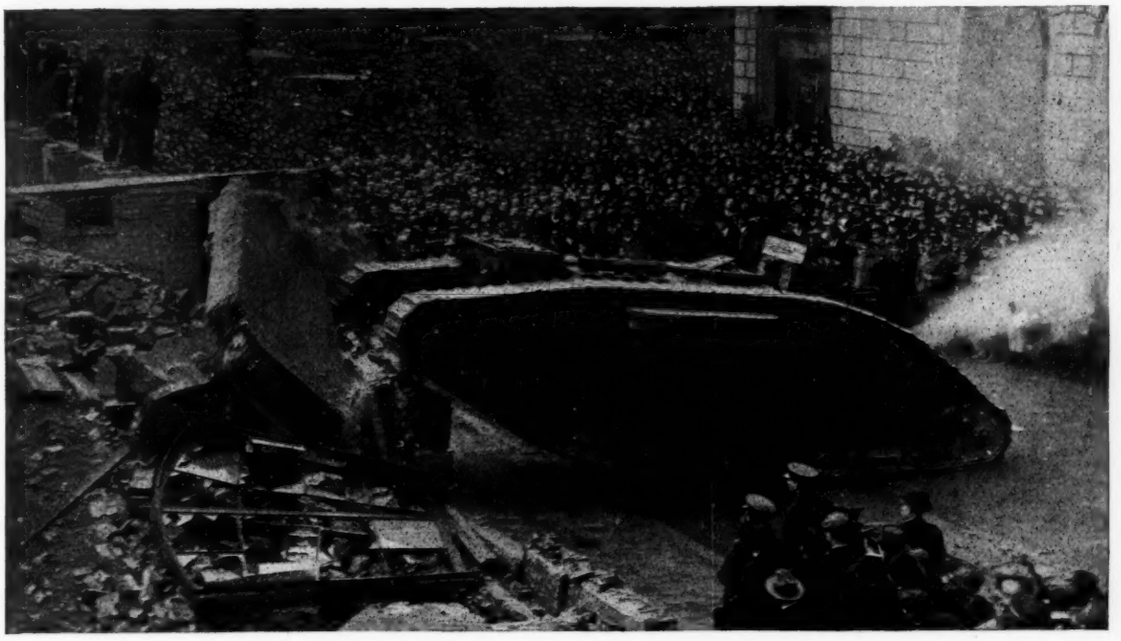
BITULITHIC stands the test of War Tank



(Photo by courtesy of *Boston Herald*)

Veteran British War Tank "Britannia" on *Bitulithic Pavement* on
Trinity Place, Boston, Mass. (Trinity Place is "opposite Copley Plaza Hotel, Westminster Hotel and Trinity Church")
Demolishing old brick walls two feet thick of old Massachusetts Institute of Technology Laboratory Buildings.

THE "BRITANNIA," *weighing over 30 tons,*
traveled over the **Bitulithic** Pavements on
Dartmouth Street, laid on old macadam, 1903. Winter Street, laid on concrete base, 1913.
Trinity Place, laid on concrete base, 1914. Commonwealth Ave., laid on old macadam, 1916.
Without causing any damage to the pavement, notwithstanding

The "Tank" proceeding through crowd preparatory to demolishing the wall.

After demolishing the wall and proceeding of the "Tank" to other activities.

The extremely heavy weight and the cleats on the caterpillar belts.
The huge weight being supported by the inherent stability and great density of the **Bitulithic Surface Mixture.**

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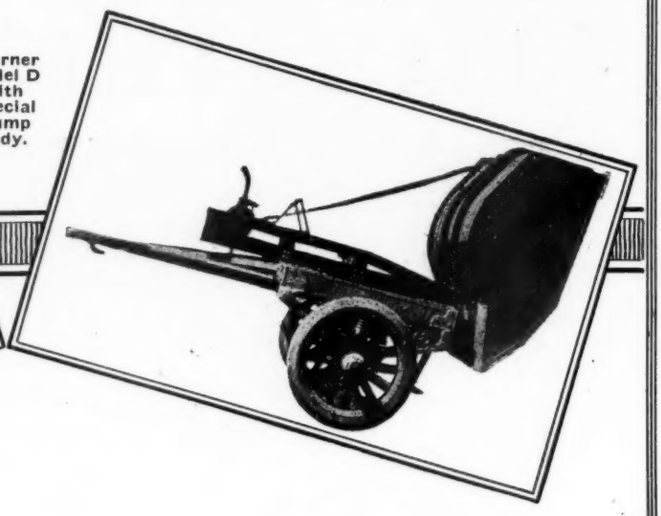
Warner Model D with Special Dump Body.



One Warner Trailer Plus One Truck Does More than Two Trucks

Expert transportation authorities have tested the use of Warner Trailers in actual service under the most strenuous conditions.

One of these tests was held at Cedar Rapids, Iowa. Here a concern delivered from two points. At one of these all hauling was handled by two 2-ton trucks; at the other by a 2-ton Warner Trailer and a 2-ton truck.

After thirty days they transposed the transportation units and repeated the test.

At each point the Warner Trailer and truck were found to handle by far the greater volume of work. And every test conducted has met with similar results.

Hauling Costs Cut in Half

The economy and the extra service offered have led America's largest motor truck users to the Warner Trailer. We quote a few of the reasons for their adoption—there are many others.

"One driver does the work of two. It takes but a moment to hitch or unhitch the trailer."

An Exclusive Warner Feature

Our universal Ball and Socket Hitch. No coupling pins. Operates like your shoulder joint. Allows for every conceivable position of the truck and trailer. Eliminates all binding strain in going over bumps, around corners or when truck is going up hill and trailer coming down, even at extreme angle.

"There is no motor upkeep or gasoline expense. So the three greatest items are eliminated."

For All Hauling

Warner Trailers are made in both two and four-wheel types and in sizes to meet every hauling need. Regular bodies or special ones as desired.

Write for full details and photographs of Trailers now in service.

Warner Manufacturing Company

125 Bushnell Avenue **BELOIT, WISCONSIN**

Inter-city Freight in the future will be largely handled by motor. Warner Trailers make possible the truck trains necessary to such service.

WARNER HEAVY DUTY TRUCK TRAILERS TWO AND FOUR WHEEL TYPES